960678

CORRECTIVE MEASURE STUDY REPORT
EAST PLANT

LEGACY SITE SERVICES, LLC
RIVERVIEW/WYANDOTTE, MICHIGAN

DISCLAIMER:
SOME FORMATTING CHANGES MAY HAVE OCCURRED WHEN THE ORIGINAL DOCUMENT WAS PRINTED TO PDF; HOWEVER, THE ORIGINAL CONTENT REMAINS UNCHANGED.

Prepared by:
Conestoga-Rovers & Associates

14496 Sheldon Road
Suite 200
Plymouth, Michigan 48170

Office: (734) 453-5123
Fax: (734) 453-5201

web: http:\\www.CRAworld.com

MAY 2010
REF. NO. 14027 (15)

TABLE OF CONTENTS

<u>LIST OF FIGURES</u>

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

This Corrective Measure Study (CMS) Report has been prepared by Conestoga-Rovers & Associates (CRA) on behalf of Legacy Site Services, LLC (LSS), agent of Arkema Inc., for the East Plant property located in Riverview and Wyandotte, Michigan (Site). The information provided herein has been prepared in accordance with the Administrative Consent Order (ACO) for the Site dated September 21, 1989 and the approved Revised Corrective Measures Study Work Plan, East Plant (CRA, June 2006).

As summarized below, the RCRA Facility Investigation (RFI) for the East Plant was completed in several phases of work and approved by the United States Environmental Protection Agency (U.S. EPA) in February 2006. Based upon the results of RFI, the U.S. EPA requested a CMS for specific Solid Waste Management Units (SWMUs)/Areas of Concern at the East Plant. Upon submittal and approval of a CMS Work Plan in June 2006, additional investigation was conducted to assist with evaluation of remedial alternatives. This CMS Report provides an evaluation of remedial alternatives for the SWMUs/Areas of Concern (based on the results of both the RFI conducted prior to 2006 and CMS investigations conducted in 2006 and 2007), and includes recommendations for selection of corrective measure alternatives.

Also included is a discussion of sediment sampling and mapping performed in the Detroit River adjacent to the East Plant shoreline. The results of this sampling have been provided to the Great Lakes National Program Office (GLNPO) of the U.S. EPA. GLNPO is currently developing a scope of work for a potential sediment remediation project that encompasses a large portion of the Trenton Channel, including the East Plant Site. LSS intends to work cooperatively with GLNPO to address impacts to sediment quality, if any, resulting from Site operations. If this project is not completed, LSS will evaluate potential corrective measures in a subsequent CMS focusing specifically on sediment.

1.1 FACILITY DESCRIPTION

The East Plant is located on approximately 90 acres along the western bank of the Trenton Channel of the Detroit River in the Cities of Riverview and Wyandotte, Michigan, as shown on Figure 1.1. The northern portion of the facility is located in the City of Wyandotte and the southern portion in the City of Riverview. The Site is bounded on the east by the Trenton Channel of the Detroit River, on the south by a decommissioned Firestone facility (now Materials Processing, Inc.), on the west by the Arkema Inc. West Plant and the Wayne County wastewater treatment plant (WWTP), and on the north by a golf course (former BASF facility). Figure 1.2 provides a layout of the facility showing current conditions at the East Plant. Figure 1.3 provides a general layout of the facility showing locations of former process buildings. Currently, a cooling water pumping station (Building 47 - used by the West Plant) and a small groundwater treatment building used as an Interim Remedial Measure (IRM) in Area 17 are the only structures that remain on-Site.

1.2 SITE BACKGROUND/REGULATORY SETTING

The East Plant facility was built in 1898. The facility operated from 1898 to 1985, when plant closure activities began. Past operations at the East Plant included production and/or distribution of inorganic and organic compounds by various companies. A history of East Plant manufacturing operations is provided in the RFI report.

In 1989, Arkema signed the U.S. EPA ACO requiring that a RFI and CMS be performed at the Site. Environmental activities completed pursuant to the ACO to date include the following items, which are described in detail in the RFI Report (CRA, July 2004) and the CMS Work Plan (CRA, June 2006):

1. Phase I RFI in 1993.
2. Remediation of the former National Pollutant Discharge Elimination System (NPDES) surface impoundments, referred to as SWMU 12 in 1994.
3. Soil boring investigation in the Halowax Area, referred to as Area 17 in 1995.
4. Construction of an IRM at the Halowax Area in 1999.
5. Phase II RFI including human-health and ecological risk assessments in 1999 (finalized in 2004).
6. Recording of Industrial/Commercial II deed restrictions in 2001.
7. Supplemental groundwater sampling to support an Environmental Indicator (EI) Determination (CA 750) in 2004.
8. East Plant shoreline sediment surveys in 2005 and 2006.
9. Qualitative analysis of tentatively identified compounds (TICs) and proposed removal action in June 2006.

In February 2006, the U.S. EPA issued a Final Determination for the CMS. Table 1.1 provides a detailed summary of SWMUs/Areas for which the U.S. EPA required further evaluation as part of a CMS. As shown in Table 1.1, there were three general items to address:

1. **Surface soil impacts:**
   a. Potential human health risks associated with benzo(a)pyrene in surface soils in the following SWMUs/Areas:
      - SWMU 1/2 (01SB05)
      - SWMU 11b (11SB15)
      - Area 20 (20SB09)

   b. Potential human health and/or ecological risks associated with polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) (herein referred to as PCDDs/PCDFs or "dioxins") in surface soils in the following SWMUs/Areas:
      - SWMU 5 (05SB02)
      - SWMU 11a (11SB05)
      - SWMU 11b (11SB04, 11SB15 and 11SB16)
      - SWMU 11c (11SB01, 11SB11 and 11SB13)
      - SWMU 14 (14SB04 and 14SB06)
      - Area 17 (17SB25 and 17SB30)
      - Area 18/19 (18SB12)
      - Area 24 (24SB08)

   c. Potential concerns associated with TICs (based on June 2006 TIC Evaluation)
      - SWMU 7 (07SB01)
      - Area 17 (17SB14)
      - SWMU 24 (24SB06)

2. **Groundwater impacts in Area 17:**
   a. Human health risks associated with chloroform in MW-017
   b. Effectiveness of the Area 17 IRM (DNAPL and groundwater containment/ recovery/treatment)

3. **Potential USTs remaining in Areas 22 and 23.**

In June 2006, LSS submitted a CMS Work Plan to address items 1 through 3, above. The Work Plan was approved by the U.S. EPA and identified five specific CMS objectives, as presented in the following section.

1.3 REMEDIAL ACTION OBJECTIVES

As stated in the approved CMS Work Plan, the CMS remedial action objectives for the East Plant are as follows:

1. Eliminate exposure pathways associated with benzo(a)pyrene and PCDDs/PCDFs, in soil through remediation or containment of contaminated media and/or implementation of institutional controls. For benzo (a) pyrene and PCDDs/PCDFs, As described in Sections 2.2.1.1 and 2.2.1.2 the Site-wide average cleanup objectives for 2,3,7,8 TCDD TEQ and benzo (a) pyrene are 0.99 parts per billion (ppb) and 8.0 parts per million (ppm) respectively.
2. Reduce the potential for exposure to TICs in soil through implementation of corrective measures detailed in the June 2006 TIC Evaluation. Due to the nature of TICs, cleanup criteria do not exist. As such, the remedial actions will not be measured against numerical goals, but are designed to reduce or eliminate the risk of potential exposure.
3. Eliminate potential exposure pathways associated with chloroform in groundwater in Area 17 through remediation or containment of contaminated media and/or implementation of institutional controls.
4. Evaluate the Area 17 IRM to determine its effectiveness at preventing migration of DNAPL and concentrations of dissolved Site-related constituents that may adversely impact water quality. If results indicate that the system is not meeting objectives, eliminate potential exposure pathways through remediation of affected media and/or enhancement of the existing system.
5. Investigate Areas 22 and 23 to determine the presence or absence of historical USTs and, if present, remove and properly close the USTs in accordance with Michigan Act 451, Part 213.

1.4 REPORT ORGANIZATION

In accordance with Attachment IV, Tasks II, III, and IV of the ACO, the remainder of this report is presented as follows:

Section 2.0 – Summary of Corrective Measure Alternatives and Rationale for Selection
Section 3.0 – Evaluation of Corrective Measure Alternatives (Task II of the ACO)
Section 4.0 – Justification and Recommendation for Corrective Measure Alternatives (Task III of the ACO)
Section 5.0 – References

2.0 SUMMARY OF CORRECTIVE MEASURE ALTERNATIVES AND RATIONALE FOR SELECTION

2.1 DESCRIPTION OF RETAINED CORRECTIVE MEASURE TECHNOLOGIES

As part of the approved CMS Work Plan (CRA, June 2006), an evaluation of prospective corrective measure technologies was completed by assessing Site and technology characteristics and applying the criteria of effectiveness, implementability and cost, consistent with U.S. EPA guidance. This evaluation eliminated ineffective or impractical potential technologies from consideration in the CMS and more feasible technologies were retained for further evaluation in the CMS. The following sections detail retained technologies for soil, groundwater and sediment impacts.

2.1.1 RETAINED TECHNOLOGIES FOR SOIL IMPACTS

No remedial action – This technology was provided as a baseline for comparison to other alternatives.

Additional Institutional controls, with monitoring as necessary – Use restrictions can mitigate potential human exposure pathways through restricting access or use of the areas. On going monitoring and/or inspections with reporting may be utilized to demonstrate the controls are effective and remain in place.

Soil Excavation and off-Site disposal – Excavation is a proven technology capable of meeting corrective action objectives by removing and transporting contaminated material to a permitted off-Site disposal facility. The technology would be effective and reliable in that it would remove potential exposure to constituents of concern. Additionally, the excavation alternative could be implemented with limited difficulty. Equipment and services for the alternative are locally available and competitively priced.

To assess the extent of excavation, CRA performed extensive soil sampling as part of this CMS. Results of the sampling are provided in Section 2.2.1.

For TICs, the extent of excavation would be guided by the TIC Evaluation (ESI, June 2006), which was included as an attachment to the CMS Work Plan (CRA, June 2006).

Capping – Capping is a proven technology for controlling contact with impacted material. Likelihood of failure is small as long as regular maintenance and inspections are performed. The technology would be effective and reliable in that it would remove potential exposure to constituents of concern. The cap can be implemented with little difficulty. Materials and services for construction, maintenance, and monitoring of the cap are locally available.

To assess the extent of capping, CRA performed extensive soil sampling as part of this CMS. Results of the sampling are provided in Section 2.2.1.

For TICs, the extent of capping would be guided by the extents identified in the TIC Evaluation (ESI, June 2006), which was included as an attachment to the CMS Work Plan (CRA, June 2006).

2.1.2 RETAINED TECHNOLOGIES FOR GROUNDWATER IMPACTS

No remedial action – This technology was provided as a baseline for comparison to other alternatives.

Additional Institutional controls, with monitoring as necessary – Use restrictions can mitigate potential human exposure pathways through restricting access or use of the areas. Ongoing monitoring and/or inspections with reporting may be utilized to demonstrate the controls are effective and remain in place.

Continue operation of the existing Area 17 containment/recovery/treatment system, as designed OR Upgrade/modify existing treatment system – These options were retained to allow for further evaluation of the Area 17 IRM. The IRM consists of the following containment, recovery and treatment elements:

- Containment walls
- Groundwater/DNAPL extraction wells
- Enhanced groundwater extraction consisting of approximately 200 trees planted throughout Area 17 on a 25-foot grid
- Groundwater treatment system, consisting of:
  - air compressor/extraction pumps
  - conical tank to collect DNAPL
  - iron filter

- equalization tank
- bag filtration
- carbon treatment

- Soil cover
- Groundwater monitoring

To assess the effectiveness of the existing system, CRA performed the following tasks:

- Installed monitoring well MW025 at the southern end of the sheet pile wall and performed two rounds of sampling in August and September 2006
- Gauged Area 17 IRM monitoring wells (IRM-MW1, IRM-MW2, IRM-MW3, MW009, MW017, MW025, RW-1 and RW-2) for the presence of DNAPL
- Tracked DNAPL recovery
- Evaluated historical flow gradients

Refer to Section 2.2.2 for details regarding the IRM evaluation.

Barrier wall extension – Barrier wall extension was identified in the CMS Work Plan as a highly effective technology that could be used to prevent potential migration of impacted groundwater to the north (toward the adjacent property).

In 2006, the existing IRM was enhanced by extending the impermeable barrier on the northern property boundary. A slurry wall extending from the terminus of the existing sheet pile wall to nearly the western property boundary was installed to prevent potential migration of Site-related constituents to the north. Refer to Section 2.2.3 for details regarding the barrier wall extension.

Capping – Capping is a proven technology for controlling surface water infiltration and thereby affecting groundwater migration patterns. Capping can also be effective at preventing direct contact with shallow groundwater and mitigating indoor air inhalation concerns. Likelihood of failure of a cap is small if regular maintenance and inspections are performed. A cap can be implemented with limited difficulty. Materials and services for construction, maintenance, and monitoring of the cap are locally available and competitively priced.

In-situ chemical oxidation (ISCO) - ISCO was retained as a potential remedy for chloroform impacts in groundwater. The technology is based on the use of strong oxidizing agents to completely oxidize the compounds within relatively short periods.

A treatability study was completed to evaluate the effectiveness of ISCO for remediation of chloroform impacts in the vicinity of MW-017. Refer to Section 2.2.4 for details.

Enhanced bioremediation – Enhanced bioremediation was retained as a potential remedy for chloroform impacts in groundwater. Enhanced bioremediation is a treatment process whereby contaminants are metabolized into less toxic or nontoxic compounds by naturally occurring microorganisms. The technology is effective against primary contaminants and can be implemented with limited difficulty.

A treatability study was completed to evaluate the effectiveness of enhanced bioremediation for remediation of chloroform impacts in the vicinity of MW-017. Refer to Section 2.2.4 for details.

Permeable reactive barrier (PRB) – PRB was retained as a potential remedy for preventing migration of contaminated groundwater. A permeable reactive barrier wall is installed across the flow path of a plume, allowing the water to passively move through the wall. These barriers allow the passage of water while prohibiting the movement of contaminants by employing such agents as zero-valent metals, sorbents, microbes, and others.

Although the PRB technology was retained, a PRB treatability study was not completed as part of this CMS. Installation of the vibrated beam slurry wall along the north property boundary (see Section 2.2.3) and lack of contaminant migration identified along the southern tip of the containment wall (see Section 2.2.2), eliminated the need for evaluation of this technology.

2.1.3 RETAINED TECHNOLOGIES FOR SEDIMENT IMPACTS

LSS intends to work cooperatively with GLNPO to address impacts to sediment quality, if any, resulting from Site operations. The GLNPO project will include a feasibility study, which evaluates potential sediment remediation technologies. If the GLNPO project is not completed, LSS will evaluate potential corrective measures in a subsequent CMS focusing specifically on sediment.

2.2 SUPPLEMENTAL CMS ACTIVITIES

Supplemental activities performed as part of the CMS included the following:

1. Surface soil sampling for benzo(a)pyrene and PCDDs/PCDFs.
2. Evaluation of the effectiveness of the existing IRM by conducting the following activities:
   - Monitoring well installation and sampling
   - DNAPL gauging/tracking
   - Evaluating historical gradients
3. Installation of a slurry wall along the north property boundary.
4. Completion of treatability studies to evaluate the effectiveness of potential groundwater treatment technologies.
5. Performance of a geophysical survey to investigate the potential presence of USTs near former building 107.
6. Sediment survey.

The following sections detail investigation activities and results.

2.2.1 BENZO(A)PYRENE AND PCDD/PCDF SAMPLING

Initially, as part of the CMS, delineation borings were installed using Geoprobe® technology adjacent to the following RFI sampling locations which were identified as having potential human health (maintenance worker) risks associated with benzo(a)pyrene in surface soils:

- SWMU 1/2 (01SB05)
- SWMU 11b (11SB15)
- Area 20 (20SB09)

Additionally, borings were installed adjacent to the following RFI sampling locations, which were identified as having potential human health (maintenance worker) and/or ecological risks associated with PCDDs/PCDFs in surface soils:

- SWMU 11a (11SB05)
- SWMU 11b (11SB16)
- SWMU 11c (11SB01, 11SB11 and 11SB13)
- SWMU 14 (14SB06)
- Area 17 (17SB25 and 17SB30)
- Area 24 (24SB08)

To evaluate benzo(a)pyrene and PCDDs/PCDFs impacts, four phases of investigation were completed. During the first phase of investigation, in August 2006, borings were installed 15 feet to the north, south, east and west of each of the above-referenced RFI sample locations. Within each borehole, samples were collected from the 0.5 to 2.5-foot interval (to remain consistent with RFI protocol for "surface soils") and from the 2.5 to 3.5-foot interval (to be consistent with previous intervals utilized Human Health and Ecological Risk Assessment [ESI, July 2004]). It should be noted that these sampling interval designations are somewhat misleading as they suggest that the uppermost six inches of soil was not sampled. This is not the case as the 0 to 0.5-foot interval generally consists of root mat, crushed stone, and other non-soil detritus. This nomenclature for sampling intervals was adopted for the Site during early investigations (early 1990s) and has been retained for consistency, however in typical contemporary environmental investigations these samples would be labeled 0 to 2.0-feet and 0 to 3.0 feet. In all cases, the sample collection interval included the soil closest to the surface

The results of the first phase of investigation were compared to 95 percent UCL concentrations that correspond to a 1×10^{-5} risk level for PCDDs/PCDFs and benzo(a)pyrene to determine whether additional sampling was necessary. As the results of the first phase did not delineate impacts to the 95 percent UCL, a second phase of investigation was conducted in October 2006.

The second phase of investigation stepped out an additional 25 feet from the borings that revealed impacts above the 95 percent UCL during the first phase of investigation but did not result in full delineation.

The third phase of investigation was conducted in December 2006 and focused on broader delineation. Each boring completed during the third phase stepped out a minimum of 50 feet from previous sample locations. Based on the results of the third round of investigation, the distribution of dioxin and benzo(a)pyrene in surface soil did not lend itself to clearly defined areas of elevated concentrations. Specifically, samples collected radially out from the initial sample locations did not reveal concentration patterns conducive to well-defined delineations.

The fourth phase of investigation was designed with the objective of determining the distribution if dioxins and benzo(a)pyrene in surface soil (i.e., are they randomly distributed across the Site or concentrated in specific areas). The investigation included a systematic grid placed across the Site with gridlines spaced approximately 156 feet apart. For this characterization effort, surface soil samples were collected from the 0.5 to 2.5 feet interval, representing the interval most likely to be contacted by maintenance workers. This conservative interval accounts for the top 0.5 feet of "clean" cover, and the underlying two feet of legacy material. The interval was chosen to ensure that the top two feet of original Site soil was characterized. Samples were collected at each node (intersection) using Geoprobe® technology. In cases where nodes fell within approximately 75 feet of an existing dioxin or benzo(a)pyrene surface sample location, no sampling was conducted, so as not to duplicate previous efforts. Based on this sampling scheme, a total of 130 PCDD/PCDF samples and 111 benzo(a)pyrene samples were collected.

Refer to Table 2.1 for a sample key and Tables 2.2A (Phases 1 – 3) and 2.2B (Phase 4 – Site-wide grid) for a summary of detected constituents in soil.

QA/QC procedures were incorporated into the soil sampling events to ensure the collection of quality data for each area investigated, and to facilitate meeting the objectives of this Report. Additionally, such QA/QC procedures were employed to ensure that all information, data, and resulting decisions are technically sound, statistically valid (accurate and precise), and properly documented, and to ensure the completeness of the data. The mechanism for employing the project QA/QC procedures was the Quality Assurance Project Plans (QAPPs), which were established as part of the RFI.

Separate from the laboratory's internal data review/data validation, a review of the final analytical data packages was performed by CRA to validate results and to determine usability. Criteria to assess usability were taken from the most applicable versions of U.S. EPA's functional guidelines on data validation. Guideline criteria were applied to available documentation. This validation was performed by CRA project chemists experienced in laboratory methods and validation procedures, and did not include those persons directly involved with the analyses.

The results of the data validations indicated that the data are usable for evaluating the conditions at the Site. Refer to Appendix H for Data Quality Assessment and Validation memoranda.

The following sections present a description of PCDD/PCDF and benzo(a)pyrene results and resulting assessment of Site-specific cleanup standards.

2.2.1.1 PCDD/PCDF SAMPLE RESULT SUMMARY AND CLEAN-UP STANDARD EVALUATION

Refer to the following figures for a depiction of sample locations and results. Results provided in the figures represent data collected from the 0.5 to 2.5 depth from 1993 through 2007 and are separated into three figures due to the quantity of data.

Figure 2.1 – Summary of PCDD/PCDF Results – North Section
Figure 2.2 – Summary of PCDD/PCDF Results – Central Section
Figure 2.3 – Summary of PCDD/PCDF Results – South Section

The additional data generated by the supplemental characterization efforts in 2006 and 2007 greatly reduced the uncertainty associated with the previous historical data set and was used, along with historical data, to assist with development of a Site-specific cleanup standard for PCDDs/PCDFs (2,3,7,8-TCDD Toxic Equivalent [TEQ]).

A cleanup standard for PCDDs/PCDFs at the Site was selected based on Michigan Act 451, Part 201 regulations, Michigan Department of Natural Resources and Environment (MDNRE) guidance with consideration of the of the U.S. EPA's draft interim Preliminary Remediation Goals (PRGs) for dioxin at industrial sites. Specifically, the Part 201 Generic Cleanup Criteria for the Industrial/Commercial II land use category is 0.99 ppb for 2,3,7,8-TCDD TEQ. Examples of the Industrial land use provided by MDNRE include manufacturing, utilities, industrial research, bulk petroleum storage, and other activities industrial in nature and with access reliably restricted by fences and/or security personnel. The East Plant property is currently deed restricted to limit land use to Industrial/Commercial II. In a letter dated April 9, 2010, U.S. EPA approved a remedial action objective (clean-up standard) for 2,3,7,8-TCDD TEQ in soil of 0.99 ppb.

Legacy Site Services proposes to achieve a 0.99 ppb cleanup goal by controlling exposures to areas depicted on Figure 2.7. These areas reflect the locations on-Site with the highest detected PCDD/PCDF concentrations. Future controls were mimicked by replacing the concentrations of the sample locations designated for remediation (capping or excavation) with a concentration of 0.001 ppb to represent background dioxin concentrations that might be present in material brought in to cap or fill the areas of interest. A 95 percent Upper Confidence Limit of the Mean Concentration (95 percent UCL) was then calculated to represent post-remediation Site conditions. The 95 percent UCL calculations were performed using U.S. EPA's ProUCL (version 4.00.04), a statistical software package used to calculated UCL statistics. After testing the data set for a normal, lognormal, or gamma distributions, U.S. EPA's ProUCL version 4.00.04 provides several UCL computation methods, both parametric and nonparametric. The non-parametric methods do not depend upon the data distributions. Based on the characteristics of the data set, ProUCL recommends a 95% UCL computation method that best represents the data.

The ProUCL recommended statistic (a 97.5 percent Kaplan-Meier Chebyshev UCL) of 0.997 ppb was used as the post-remediation 95 percent UCL in this assessment (Appendix A). This UCL corresponds to a maintenance worker risk level of $3x10^{-5}$ (using the same exposure assumptions and parameters as those used in the U.S. EPA-approved 2004 risk assessment). This post-remediation 2,3,7,8-TCDD TEQ risk level is well within U.S. EPA's acceptable risk range of $1x10^{-6}$ to $1x10^{-4}$, and the associated 95 percent UCL meets the MDNRE Industrial generic cleanup criteria for direct contact with soil. Accordingly, remediation of the proposed areas depicted on Figure 2.7 would address risks associated with 2,3,7,8-TCDD TEQ at the East Plant Site.

2.2.1.2 BENZO(A)PYRENE SAMPLE RESULT SUMMARY AND CLEAN-UP STANDARD EVALUATION

Refer to the following figures for a depiction of benzo(a)pyrene sample locations and results. Results provided in the figures represent data collected from the 0.5 to 2.5 depth from 1993 through 2007 and are separated into three figures due to the quantity of data.

Figure 2.4 – Summary of Benzo(a)pyrene Results – North Section
Figure 2.5 – Summary of Benzo(a)pyrene Results – Central Section
Figure 2.6 – Summary of Benzo(a)pyrene Results – South Section

To evaluate cleanup associated with benzo(a)pyrene, the proposed remediation areas described in Section 2.2.1.1, and presented on Figure 2.7, were carried through to the benzo(a)pyrene data set. Specifically, all benzo(a)pyrene results situated below the proposed remediation areas were replaced with a surrogate concentration of 0.33 ppm to represent "background" concentrations that might be present in material brought in to fill or cap the areas of interest. The 0.33 ppm value is the Target Detection Limit (TDL) provided by the MDNRE Remediation and Redevelopment Division (RRD) in its Operational Memorandum No. 2 (October 2004). Doing this resulted in a 95 percent UCL of 7.268 ppm (a 97.5 percent Kaplan-Meier Chebyshev UCL) for benzo(a)pyrene (Appendix A). Using the same exposure assumptions and parameters as those used in the 2004 U.S. EPA-approved risk assessment and an exposure-point concentration of 7.268 ppm, the resultant maintenance worker risk level for benzo(a) pyrene was 9.8×10^{-6}. This risk level is well within U.S. EPA's acceptable risk range of 1×10^{-4} to 1×10^{-6}, and the associated 95 percent UCL (7.268 ppm) meets the MDNRE Industrial generic cleanup criteria for direct contact with soil of 8.0 ppm. In a letter dated April 9, 2010, U.S. EPA approved a remedial action objective (clean-up standard) for benzo(a)pyrene in soil of 8.0 ppm. Accordingly, remediation of the areas depicted on Figure 2.7 would address risks associated with benzo(a)pyrene at the East Plant Site.

2.2.2 AREA 17 IRM EVALUATION

2.2.2.1 MONITORING WELL INSTALLATION AND SAMPLING

As part of the Area 17 IRM evaluation, one additional monitoring well (MW025) was installed in Area 17, as depicted on Figure 2.8. Originally two monitoring wells were slated for installation (one at each end of the existing sheet pile wall). However, the northern sheet pile wall was extended 600 feet to the west (see Section 2.2.3), eliminating the need for a well at the western end of the sheet pile wall along the north property boundary. MW025 was installed at the southern end of the sheet pile wall (where groundwater could migrate around the wall and discharge to the Trenton Channel).

The borehole was drilled using 4.25-inch hollow-stem augers and during completion of the boreholes, continuous soil samples were collected for visual observation. At the time of drilling a CRA geologist was on-Site to examine each interval for color, soil type, stratigraphy, banding, moisture, odor, visual and olfactory evidence of impact, and to screen for total organic vapors with a photoionization detector (PID). Additionally, all saturated soil samples were screened for dense non-aqueous phase liquids (DNAPL) using Sudan IV. All soil samples were described and classified according to the Unified Soil Classification System (USCS) and recorded on a boring log. Refer to Appendix B for the MW025 stratigraphic and instrumentation log.

During installation of MW025, no DNAPL was identified visually or through screening using Sudan IV.

Upon completion of the borehole, the monitoring well was constructed using a 2-inch inside diameter, 5-foot long, 0.010-inch slot Schedule 40 polyvinyl chloride (PVC) well screen threaded to a 2-inch inside diameter riser to the ground surface. The bottom of the well was situated approximately 6 inches into the underlying clay layer to act as a sump for the purposes of identifying potential DNAPL. A sandpack compatible with the well screen was placed from the base of the borehole to approximately 2-feet above the top of the well screen. The remaining annulus was filled with bentonite pellets and hydrated to create a seal. The monitoring well riser was secured with an expandable cap and a stand-up protective casing was concreted in place at grade.

Upon completion of well installation, the monitoring well was developed to a visually silt free condition to improve hydraulic communication between the well and the formation.

Investigative-derived waste (IDW) generated during drilling and development was placed in DOT-approved 55-gallon drums and disposed of at an appropriately permitted off-Site disposal facility.

Following 48-hours to allow for stabilization, the monitoring well was first sampled in August 2006. An additional sampling event was conducted in September 2006 to establish an adequate suite of data for evaluation. Each sample was analyzed for target compound list (TCL) volatile organic compounds (VOCs) and TCL Semi-volatile organic compounds (SVOCs), consistent with the approved CMS Work Plan. Refer to Table 2.1 for a sample key.

Table 2.3 presents a summary of groundwater analytical results. During the sampling events, trace concentrations of the following constituents were detected, all of which were detected well below the most conservative Michigan Act 451, Part 201 Groundwater criteria:

SVOCs	VOCs
acenaphthylene	2-butanone
bis(2-ethylhexyl)phthalate	carbon disulfide
2,4-dimethylphenol	chlorobenzene
fluorene	1,2-dichlorobenzene
4-methylphenol	1,4-dichlorobenzene
phenanthrene	

2.2.2.2 DNAPL GAUGING

In addition to sampling MW025, seven monitoring wells in Area 17 (IRM-MW1, IRM-MW2, IRM-MW3, MW009, MW017, RW-1 and RW-2) were evaluated for the presence of DNAPL using an oil/water interface probe, as follows:

Well ID	Depth to Water (ft btoc)	Depth to DNAPL (ft btoc)	Total Depth (ft btoc)	DNAPL Thickness (ft)
IRM-MW-1	6.93	ND	22.25	--
IRM-MW-2	6.95	20.20	21.50	1.30
IRM-MW-3	6.50	ND	21.50	--
MW009	6.43	13.83	16.14	2.31
MW017	6.18	ND	16.01	--
MW025	8.31	ND	21.80	--
RW-1	3.45	ND	10.00	--*
RW-2	4.95	ND	12.25	--*

ND – No DNAPL Detected
ft btoc - feet below top of casing
* - Lack of DNAPL present at a measurable level in RW-1 and RW-2 due to active system operation/DNAPL extraction.

Monitoring well locations are shown on Figure 2.8.

As shown, DNAPL was non-detect in all wells with the exception of MW009 and IRM-MW-2. In both cases the DNAPL was black in color and viscous (consistent with what is observed in the treatment system waste stream). DNAPL limited to IRM-MW-2 and MW009 is consistent with what has been found since initiation of the IRM and indicates DNAPL plume stability.

On October 5, 2006, CRA removed approximately 0.75 gallons of DNAPL from MW009 using a peristaltic pump. An attempt was also made to remove product from IRM-MW-2 but the viscosity of the product in that well (possibly due to sediment accumulation in the well) inhibited removal using a peristaltic pump. DNAPL removed from MW009 was placed in the existing treatment system DNAPL drum for proper disposal.

On October 20, 2006 CRA re-gauged MW-009 for the presence of DNAPL to evaluate DNAPL recovery and attempted to remove product from IRM-MW-2 using a bailer. Two feet of product was identified and removed from MW-009 (totaling approximately 0.3 gallons) and approximately 0.2 gallons was removed from IRM-MW-2. DNAPL removed from the wells was placed in the existing treatment system DNAPL drum for proper disposal.

DNAPL removal during the two events totaled approximately 1.25 gallons.

2.2.2.3 DNAPL RECOVERY

The Area 17 IRM collects impacted groundwater and DNAPL from two extraction wells (RW-1 and RW-2) that are located within an interceptor trench running parallel to the Trenton Channel and just inside a sheet-pile containment wall. Captured groundwater and DNAPL are pumped to a treatment system where DNAPL is collected and removed and groundwater is treated prior to discharge to the local POTW.

The first step in the system is a conical DNAPL collection tank. Water at the top of the tank gravity flows for further treatment, while DNAPL accumulates at the bottom for removal. Following DNAPL separation, water gravity flows into an iron filter and then an equalization tank (EQ tank). When the EQ tank reaches capacity, water is pumped through bag filters and then liquid-phase granular activated carbon (GAC) for final treatment prior to discharge to the POTW. The system treats groundwater at an average rate of approximately 300 gallons per day (approximately 9,000 gallons per month or 27,000 gallons per quarter). Depending on the season and rainfall, the system has removed up to approximately 850 gallons per day.

DNAPL is collected through a valve at the bottom of the conical tank on a monthly basis, as part of standard operation and maintenance activities. Since regular operation of the system began in 2001, approximately 385 gallons (seven 55-gallon drums) of DNAPL has been recovered and properly disposed.

DNAPL is stored on-Site in 55-gallon drums and disposed periodically when waste accumulates.

2.2.2.4 EVALUATION OF HISTORICAL GRADIENTS

Groundwater and surface water elevations have been monitored since installation of the Area 17 IRM. Specifically, seven wells (IRM-MW1, IRM-MW2, IRM-MW3, MW009, MW017, RW-1 and RW-2) and the surface water elevation in the Trenton Channel have been gauged on a monthly basis since 2001 using an electronic water level indicator. All groundwater and surface water monitoring results are presented in Table 2.4. Results are referenced in feet above mean sea level using the North American Vertical Datum of 1988 (NAVD 88).

As shown on Table 2.4, when comparing surface water levels of the Trenton Channel to groundwater levels in the wells located away from the shoreline (IRM-MW1, MW009 and MW017), groundwater levels are higher than surface water levels, which indicates that groundwater flows toward the Trenton Channel (outward gradient). However, when comparing surface water levels to groundwater levels in the monitoring wells located closest to shore (IRM-MW2, IRM-MW3, RW-1 and RW-2), an inward gradient is predominant, which demonstrates that the containment and recovery system is depressing the water table and limiting migration of impacted groundwater toward the Trenton Channel.

2.2.2.5 IRM EVALUATION CONCLUSIONS

The IRM consists of containment, recovery and treatment elements, which, as described in Sections 2.2.2.1 though 2.2.2.4, are collectively:

- Capturing and removing DNAPL from the subsurface (approximately 385 gallons to date)
- Capturing and treating impacted groundwater within Area 17 (approximately 800,000 gallons to date)
- Limiting migration of impacted groundwater toward the Trenton Channel
- Preventing migration of impacted groundwater and DNAPL around the southern portion of the containment wall

Additionally, together with the barrier wall extension along the northern property line, which is described in detail in the following section, the containment and recovery system serves the dual purpose of containing (and ultimately collecting and treating) chloroform impacts that have been identified MW017.

2.2.3 BARRIER WALL EXTENSION

As presented in the Phase I and II RFIs and in the Environmental Indicator Determination for the Site, groundwater in the vicinity of Area 17 flows predominately in an easterly to northeasterly direction, toward the Trenton Channel. It is possible that the slight northerly component of groundwater flow observed in this area was the result of significant groundwater pumping operations taking place on the property adjacent to the north (groundwater extraction and treatment system operated by BASF Corporation).

To prevent migration of chloroform-impacted groundwater to the north and to allow groundwater to flow naturally to the east, where capture and treatment can occur, LSS contracted Slurry Systems, Inc. (SSI) to install a cut-off wall.

Prior to wall installation, LSS cleared and grubbed the northern property boundary and established a staging area for operations. Work was conducted between October 18 and October 24, 2006 in accordance with the *"Work Plan for Vibrated Beam Slurry Wall"* submitted to the U.S. EPA in September 2006.

The barrier wall was tied into the western edge of the existing northern sheetpile wall and extended 600 feet to the west. The wall was installed to an average depth of approximately 18 feet below ground surface, keyed approximately 3 feet into the native clay layer. Refer to Figure 2.8 for the location of the barrier wall extension. The slurry used to create the impermeable barrier was IMPERMIX®, which consists of a controlled mixture of attapulgite clay, slag cement and water.

Installation was completed using a FUNDEX F-12 80,000-lb crane equipped with a PTC 2-75 vibrator and specially fabricated 33-inch steel I-beam. The vibrated beam method consisted of vibrating the I-beam from the surface to the clay layer while the IMPERMIX® (mixed in a portable batch plant) was injected through nozzles affixed to the bottom of the beam. Slurry was injected during insertion and extraction of the beam and the continuous cutoff wall was created by overlapping each 33-inch beam by 17 inches. Injection of the slurry using this method creates a continuous 4-inch thick cutoff wall with a typical in-situ permeability of approximately 1×10^{-8} cm/sec.

Batch plant and vibrated beam production records were maintained during installation and are provided in Appendix C. Batch plant production records include slurry ingredients, mixing time for each batch, slurry volume produced for each batch, and quality control. Production records during driving of the vibrated beam included total penetration depth of each beam drive, depth of key-in penetration of each beam, driving pressure for each beam, and any significant comments regarding equipment performance, obstructions encountered, etc.

By placing the barrier wall along the north property line, chloroform identified in MW017 is contained on-Site and is allowed to move naturally toward the recovery wells for subsequent extraction and treatment.

2.2.4 TREATABILITY STUDY RESULTS

2.2.4.1 ISCO

Refer to Appendix D for a detailed description of the ISCO treatability study.

Fenton's Reagent was selected as the preferred oxidant for the treatment. As part of the treatability study, CRA assessed the effectiveness of ISCO using Fenton's Reagent, including determination of the dosages of oxidant that are required to effectively oxidize the contaminants present (referred to as stoichiometric demand) as well as the competing reactions. Additionally, in order to assess the potential release of heavy metals as a result of the Fenton's Reagent treatment, metals leaching tests were conducted.

Based on the results of the study, it appears that chemical oxidation treatment may achieve reductions in chloroform levels. During the study, 50 percent of the chloroform in the soil and 43 percent in the groundwater was removed by chemical oxidation over a two-week study period.

Metal leach testing revealed that barium, magnesium, manganese, nickel and selenium may be mobilized.

2.2.4.2 ENHANCED BIOREMEDIATION

Refer to Appendix D for a detailed description of the enhanced bioremediation treatability study.

As part of the treatability study, CRA assessed the effectiveness of enhanced anaerobic biodegradation, including determination of the recommended doses of amendments required for removal of contaminants.

Based on the results of the study, it appears that enhanced bioremediation using soy lactate and nutrients may achieve reductions in chloroform levels. Twenty-nine percent of the chloroform in the soil and groundwater microcosms was removed by biological treatment during the 8-week study period.

2.2.5 GEOPHYSICAL SURVEY – AREA 22/23

In October 1993, during an investigation by Arkema, two potential underground storage tanks were reportedly discovered east of former Building 107. The tanks were estimated to be 7 feet in diameter and 30 feet long, with an approximate capacity of 9,000 gallons each. The tanks were found to be nearly full of liquid. Analysis of the liquid in the tanks showed that benzene and chlorobenzene were the main compounds present. The contents of the tanks were removed and transported to a proper disposal facility. Although the tanks were emptied, it was uncertain if the tanks were removed. As such, the area east of former building 107 was evaluated to verify whether or not USTs are present.

To investigate the presence of USTs, a geophysical investigation was performed by using electromagnetic (EM) terrain conductivity on August 8 and 9, 2006. Prior to conducting the survey, brush clearing was performed and a grid system was established to provide a means of surface control during data collection. The survey grid was established based on a relative coordinate system using existing monuments and land features and spaced appropriately to locate the USTs. Refer to Appendix E for a detailed description of geophysical survey procedures and results.

As shown in Appendix E, several anomalies were identified east of Building 107. To verify the anomalies, test pits were performed on August 16, 2006. Due to its size and location, Anomaly A was excavated first. The area contained a shallow depression that was approximately 45 feet in length, oriented parallel to Building 107. In this area a 6-inch diameter, 40-foot long iron pipe (bulkheaded at both ends) was identified within two feet of the surface. The bulkheaded lines are thought to have been associated with the former USTs. Excavation to a depth of approximately 6 to 8-feet bgs along both sides of the 6-inch pipe revealed additional lengths of buried pipe, valves, and miscellaneous metals debris, but did not reveal underground storage tanks. Excavation further south of Anomaly A, where a low-level response indicated a possible additional pipeline leading away from the anomaly (identified as Anomaly E in Appendix E), revealed a buried metal wire close to the surface.

Although Anomaly A is thought to be the location of the former tanks, three additional anomalies were excavated to verify contents. Anomaly B revealed a 12-inch diameter, 15-foot long iron pipe within two feet of the surface. Excavation to a depth of approximately 6-feet bgs in the area of Anomaly B did not reveal an underground storage tank. Anomaly C, much smaller than anomalies A and B, revealed miscellaneous metal debris, including rebar, and a small reinforced concrete wall (likely a former foundation). Similarly, Anomaly D revealed rebar and a cluster of small diameter metal wire, close to the surface. Anomaly F, was not excavated due to its small size (i.e., too small to be a 9,000 gallon UST) and close proximity to an active 30″ water line traversing the area.

Refer to Appendix F for test pit photographs.

2.2.6 SEDIMENT SURVEY

LSS performed soft sediment surveys in 2005 and 2006. The study area included the entire East Plant shoreline (totaling approximately 2,800 feet) and a 250-foot stretch of shoreline north of the east plant, out to the 25-foot depth contour of the Trenton Channel. The studies were conducted to develop an understanding of the soft sediment volume, depth of water, potential subsurface obstructions, and sediment characteristics (physical and chemical).

As part of the survey the riverbed was mapped using a combination of multibeam depth sounding and side scan sonar techniques. Additionally, evaluation of the near surface sediment layering (sediment thickness) was conducted using chirp acoustic subbottom profiling, qualitative probing, and vibratory coring. Upon completion of vibratory cores, representative sediment samples were also collected for laboratory analyses. In addition to collected samples along the Site shoreline, one upstream sample was collected.

The surveys estimated that approximately 67,500 cubic yards of soft sediment are present along the East Plant shoreline. Additionally, laboratory analysis of samples collected from the area adjacent to the Site exhibited detectable concentrations of several metals and SVOCs. Constituent concentrations were highly variable but, in general, tended to decrease in concentration with depth.

Results of the surveys were submitted to the U.S. EPA in December 2005 and November 2006. Sediment survey work plan and report references are provided in Section 5.0. Due to the size of the reports, they have not been included as attachments.

2.3 SELECTED ALTERNATIVES FOR EVALUATION

As identified in Section 1.3 there are three general items to address as part of this CMS:

1. Surface soil impacts – PCDDs/PCDFs, benzo(a)pyrene and TICs (multiple SWMUs).
2. Groundwater impacts in Area 17.
3. Potential USTs remaining in Area 22/23.

As detailed in Section 2.2.5, the geophysical survey/test pitting did not reveal the presence of underground storage tanks. As such, item 3 will not be evaluated further.

The following sections detail selected alternatives for soil and groundwater impacts developed from the retained technologies listed in Sections 2.1.1 and 2.1.2 and based on the results of the supplemental CMS activities identified in Section 2.2.

Sediment cleanup alternatives are not evaluated as part of this report. As stated previously, to address sediment issues, LSS anticipates participating in GLNPO efforts associated with the GLLA.

2.3.1 SOIL ALTERNATIVES

The CMS objectives for soil impacts are as follows:

1. Eliminate exposure pathways associated with PCDDs/PCDFs and benzo(a)pyrene in soil through remediation or containment of contaminated media and/or implementation of institutional controls.
2. Reduce the potential for exposure to TICs in soil through implementation of corrective measures detailed in the June 2006 TIC Evaluation.

For soil impacts, three general options are available from the retained technologies for selection of alternatives: institutional controls, capping and excavation. Considering these technologies, the following alternatives were selected for review as part of this CMS:

- **Soil Alternative No. 1** - Institutional Controls
- **Soil Alternative No. 2** - Capping
- **Soil Alternative No. 3** - Excavation and off-Site Disposal
- **Soil Alternative No. 4** – on-Site Consolidation

A broad conceptual design and summary of these remedial alternatives is provided in the following sections. The final detailed design of the selected remedial alternative will be completed prior to implementation of the remedial action. As part of the design process, minor necessary modifications to the conceptual design may be made.

2.3.1.1 SOIL ALTERNATIVE NO. 1 – INSTITUTIONAL CONTROLS

Alternative No. 1 involves the use of institutional controls to limit potential risk of exposure to the SWMUs/Areas. Use restrictions would be implemented for the identified areas of concern and would limit future activities and thereby reduce the potential risk of exposure. Future use and activities (e.g. excavation) would be limited, unless necessary precautions were met. Periodic inspections of the areas would be performed to confirm that the use restrictions continued to be maintained. Specific terms of the restrictions would be detailed as part of final design, but it is anticipated that the institutional controls would include future land use limitations, plus restrictions on disturbance in the areas. If disturbance of the soils was necessary, it would be completed only after appropriate plans and controls were in place (e.g., Health and Safety Plan with appropriate PPE and monitoring).

2.3.1.2 SOIL ALTERNATIVE NO. 2 – CAPPING

Alternative No. 2 utilizes a soil cap to remove potential risk of exposure by installing a physical barrier. A 2-foot thick soil barrier with vegetative cover would be installed over the boundaries identified during PCDD/PCDF and benzo(a)pyrene sampling (Section 2.2.1) and the East Plant TIC Evaluation conducted by Environmental Standards Inc. (ESI, June 2006).

PCDD/PCDF and Benzo(a)Pyrene Remediation Areas

The estimated extents of capping for each area, based on PCDD/PCDF and benzo(a)pyrene sampling, are presented on Figure 2.7 and summarized below:

Capping Area (Displayed on Figure)	Area (Acres)
A	5.06
B	1.93
C	1.76
D	0.43
E	2.94
F	0.38
G	1.96
H	1.11
TOTAL	**15.57**

Prior to placement of each cap, clearing and grubbing would be required to prepare the areas. The Area A cap, identified above, is located in Area 17 and would require removal of phytoremediation trees currently functioning to enhance groundwater extraction associated with the Area 17 IRM. Although the trees would be removed, the soil barrier and vegetative cover put in their place would serve a similar function by limiting groundwater infiltration.

As described in Section 2.2.1.1 and 2.2.1.2, these capped areas would achieve a 95% UCL of 0.99 ppb for PCDDs/PCDFs and 7.268 ppm for benzo(a)pyrene, which correspond to maintenance worker risk levels of $3x10^{-5}$ and 9.8×10^{-6}, respectively. Both risk levels are within U.S. EPA's acceptable risk range of $1x10^{-6}$ to $1x10^{-4}$. Additionally, the associated 95% UCLs meet the MDNRE Generic Industrial Cleanup Criteria for direct contact with soil. Accordingly, capping the proposed areas listed above and depicted on Figure 2.7 would address risks associated with PCDDs/PCDFs and Benzo(a)pyrene at the East Plant Site.

TIC Remediation Areas

The TIC Evaluation concluded that removing or precluding contact with specific hot spots would reduce potential risk to Site receptors from exposure to TICs. The estimated extents of capping for each area, based on the TIC evaluation, are presented on Figure 2.7 and summarized below:

Capping Area (Displayed on Figure)	Length (feet)	Width (feet)	Area (Acre)
I (Area 17)	160	60	0.22
J (Area 24)	70	51	0.08
K (SWMU 7)	12	18	0.005
		TOTAL	**0.31**

Also refer to Appendix G for excerpts from the June 2006 TIC evaluation completed by ESI, which depict the proposed TIC capping areas.

In addition to capping the specified areas, further protection against the risk of potential exposure would be provided through use of institutional controls. The institutional controls would provide for regular inspection of the caps to ensure their integrity and limit activities in the areas to protect workers. For example, any necessary excavations in the restricted areas would only be performed with trained workers (OSHA 1910 trained), under a specific Health and Safety Plan, and with appropriate control and disposal of any generated waste material. These use restrictions would be in addition to the existing Site restrictions, which limit future land use to industrial uses and prohibit use of shallow groundwater.

2.3.1.3 SOIL ALTERNATIVE NO. 3 – EXCAVATION AND OFF-SITE DISPOSAL

Alternative No. 3 considers excavation and disposal of impacted material, the extent of which is based on PCDD/PCDF and benzo(a)pyrene sampling (Section 2.2.1), and the East Plant TIC Evaluation conducted by Environmental Standards Inc. (ESI, June 2006).

PCDD/PCDF and Benzo(a)Pyrene Remediation Areas

The estimated extents of excavation for each area, based on PCDD/PCDF and benzo(a)pyrene sampling, are presented on Figure 2.7 and summarized below:

Excavation Area (Displayed on Figure)	Area (Sq. ft.)	Depth (feet)*	Volume (CY)
A	220,414	2.5	20,400
B	84,071	2.5	7,800
C	76,666	2.5	7,100
D	18,731	2.5	1,700
E	128,066	2.5	11,850
F	16,553	2.5	1,550
G	85,378	2.5	7,900
H	48,352	2.5	4,500
		TOTAL	**62,800**

* Includes 0.5 feet of topsoil/root mat and the underlying 2 feet of soil

As part of excavation in each area, clearing and grubbing would be required. Excavation Area A, identified above, is located within Area 17 and would require removal of phytoremediation trees currently functioning to enhance groundwater extraction associated with the IRM. Although the trees would be removed, the backfilled soil barrier and vegetative cover put in their place would serve a similar function by limiting groundwater infiltration.

As described in Section 2.2.1.1 and 2.2.1.2, these excavation areas would achieve a 95 percent UCL of 0.99 ppb for PCDDs/PCDFs and 7.268 ppm for benzo(a)pyrene, which correspond to maintenance worker risk levels of 3×10^{-5} and 9.8×10^{-6}, respectively. Both risk levels are within U.S. EPA's acceptable risk range of 1×10^{-6} to 1×10^{-4}.

Additionally, the associated 95% UCLs meet the MDNRE Generic Industrial Cleanup Criteria for direct contact with soil. Accordingly, excavation and off-Site disposal of the proposed areas listed above and depicted on Figure 2.7 would address risks associated with PCDDs/PCDFs and Benzo(a)pyrene at the East Plant Site.

TIC Remediation Areas

The estimated extents of excavation for each area, as detailed in the TIC evaluation, are presented on Figure 2.7 and summarized below:

Excavation Area (Displayed on Figure)	Length (feet)	Width (feet)	Depth (feet)	Volume (CY)
I (Area 17)	160	60	4	1,411
J (Area 24)	70	51	6.5	858
K (SWMU 7)	12	18	6.5	53
			TOTAL	**2,322**

Also refer to Appendix G for excerpts from the June 2006 TIC evaluation completed by ESI, which depict the proposed TIC excavation areas.

Excavation areas would be surveyed and staked prior to excavation based on the TIC evaluation and delineation sampling results. Staked areas would be excavated and no additional sampling would be performed. Following excavation, the areas would be backfilled with clean soil and topped with six inches of topsoil and seeded with a native mix.

Based on analytical data, material removed from TIC, PCDD/PCDF and benzo(a)pyrene areas would be considered non-hazardous. For cost estimation purposes, this evaluation assumes that all waste would be disposed at a Subtitle D landfill in Michigan.

In addition to removal of the specified areas, further protection against the risk of potential exposure could be provided through use of institutional controls. For example, any necessary excavations on-Site would only be performed with trained workers (OSHA 1910 trained), under a specific Health and Safety Plan, and with appropriate control and disposal of any generated waste material. These use restrictions would be in addition to the existing Site restrictions, which limit future land use to industrial uses and prohibit use of shallow groundwater.

2.3.1.4 SOIL ALTERNATIVE NO. 4 – ON-SITE CONSOLIDATION

Alternative No. 4 considers excavation and on-Site relocation of impacted soil. For this alternative, soil would be excavated from areas of impacted soil (PCDD/PCDF, benzo(a)pyrene and TIC areas), placed in Area 17 and capped with a 2-foot thick soil barrier with vegetative cover. Refer to Figure 2.7 for a depiction of the proposed consolidation area.

For this alternative, Areas B, C, D, E, F, G, H and K would be excavated and placed in Area 17 for capping. Due to their location beneath the consolidation area, Areas A, I and J would not be excavated.

The total volume of material from Areas B, C, D, E, F, G, H and K would be approximately 42,500 cubic yards (see volumes identified in Section 2.3.1.3). Based on this quantity of material, the consolidation area would be approximately 5 feet in height (3 feet of excavated material and 2 feet of cap) and encompass approximately 8 acres. As shown on Figure 2.7, the area would lie within the boundaries of the existing treatment system sheetpile and slurry walls.

Excavation areas would be surveyed and staked prior to excavation. No additional samples would be collected from the limits of excavations. Following excavation, the areas would be backfilled with clean soil, topped with six inches of topsoil and seeded with a native mix.

Prior to placement of the consolidated material, clearing and grubbing would be required to prepare the area. This would require removal of phytoremediation trees currently functioning to enhance groundwater extraction associated with the Area 17 IRM. Although the trees would be removed, the consolidated soil and cap put in their place would serve a similar function by limiting groundwater infiltration.

Area 17 was selected as the consolidation area due to the presence of like impacts as well as long term groundwater control and treatment in the area. These characteristics meet Michigan Act 451, Part 201 administrative rule (Rule 299.5542) requirements for relocation of soil on-Site and, upon capping to prevent direct contact with the material, the area as a whole would provide protection of human health and the environment. Additionally, placing material in Area 17, which is located in the northeastern corner of the property, would provide an opportunity for redevelopment of more than 80 acres located south of the area.

In addition to consolidation of the specified areas, further protection against the risk of potential exposure would be provided through use of institutional controls. The institutional controls would provide for regular inspection and maintenance of the cap to ensure its integrity and limit activities in the areas to protect workers. For example, any necessary excavations in the restricted areas would only be performed with trained workers (OSHA 1910 trained), under a specific Health and Safety Plan, and with appropriate control and disposal of any generated waste material. These use restrictions would be in addition to the existing Site restrictions, which limit future land use to industrial uses and prohibit use of shallow groundwater.

2.3.2 GROUNDWATER ALTERNATIVES

For groundwater impacts there are two areas of concern. One associated with chloroform that has been identified in MW017 and one associated with potential migration of impacted groundwater to the Trenton Channel. Specifically, the CMS objectives for groundwater impacts are as follows:

1. Eliminate potential exposure pathways associated with chloroform in groundwater in Area 17 through remediation or containment of contaminated media and/or implementation of institutional controls.
2. Evaluate the Area 17 IRM to determine its effectiveness at preventing migration of DNAPL and concentrations of dissolved Site-related constituents that may adversely impact water quality. If results indicate that the system is not meeting objectives, eliminate potential exposure pathways through remediation of affected media and/or enhancement of the existing system.

Evaluations described in Sections 2.2.2.1 through 2.2.2.4 indicate that the IRM is meeting objectives. As such, the selected groundwater alternatives utilize existing containment and recovery components (the barrier wall extension and continued operation of the existing Area 17 IRM) as part of each potential remedy.

For concerns associated with chloroform in groundwater in Area 17, three general options are available for selection from the retained technologies. These are institutional controls, containment, and in-situ treatment. Based on these options and considering the newly installed barrier wall extension as well as the results of the IRM evaluation, the following alternatives were selected for review as part of this CMS for groundwater impacts:

- **Groundwater Alternative No. 1** – Institutional controls and monitoring along with the barrier wall extension and continued operation of the existing Area 17 containment and recovery system.
- **Groundwater Alternative No. 2** - ISCO groundwater treatment with barrier wall extension and continued operation of the existing Area 17 containment and recovery system.
- **Groundwater Alternative No. 3** - Enhanced bioremediation groundwater treatment with barrier wall extension and continued operation of the existing Area 17 containment and recovery system.

A broad conceptual design and summary of these remedial alternatives is provided in the following sections. The final detailed design of the selected remedial alternative will be completed prior to implementation of the remedial action. As part of the design process, minor necessary modifications to the conceptual design may be made.

2.3.2.1 GROUNDWATER ALTERNATIVE NO. 1 – INSTITUTIONAL CONTROLS, BARRIER WALL EXTENSION AND CONTINUED OPERATION OF AREA 17 IRM

Groundwater Alternative No. 1 utilizes institutional controls and monitoring along with the newly installed barrier wall extension and continued operation of the existing Area 17 containment and recovery system.

Institutional controls would limit future activities and thereby reduce the potential risk of exposure. Future use (i.e., construction of buildings) and activities (e.g. excavation) would be prohibited, unless necessary precautions were met. Specific terms of the restrictions would be detailed as part of final design, but it is anticipated that the institutional controls would include future land use limitations, plus restrictions on disturbance in the areas. If disturbance of the soils would be necessary, it would be completed only after appropriate plans and controls were in place (e.g., Health and Safety Plan with appropriate PPE and monitoring).

In addition to institutional controls being filed for the property, the barrier wall and treatment system would continue to capture and treat impacted groundwater/DNAPL and limit migration of impacted groundwater toward the Trenton Channel. As part of operation of the Area 17 IRM, the system would be inspected monthly to ensure constant operation, groundwater levels and surface water levels would be recorded to evaluate hydraulic gradients and DNAPL would be recovered from the system for proper disposal. In addition to monthly operation and maintenance activities, a regular groundwater monitoring program would be implemented to monitor groundwater within Area 17. Groundwater monitoring would occur annually and would include sampling of the following 12 wells for VOCs, SVOCs, PCBs, RCRA metals and PCDDs/PCDFs (refer to Figure 2.8):

IRM-MW-1	MW109	MW016
IRM-MW-2	MW209	MW017
IRM-MW-3	MW10A	MW022
MW009	MW011	MW025

The purpose of the annual event would be to monitor groundwater quality in the area (upgradient, source area and downgradient), ensure that impacts do not migrate around the southern end of the containment wall, and gauge DNAPL levels in area monitoring wells. Where encountered, DNAPL would be recovered from monitoring wells using a peristaltic pump (this recovery would be in addition to the active treatment system recovery).

2.3.2.2 GROUNDWATER ALTERNATIVE NO. 2 – ISCO, BARRIER WALL EXTENSION AND CONTINUED OPERATION OF AREA 17 IRM

Groundwater Alternative No. 2 utilizes ISCO groundwater treatment with barrier wall extension and continued operation of the existing Area 17 containment and recovery system.

For this option, ISCO would be utilized to mitigate concerns associated with chloroform in groundwater over an area approximately 250 feet by 250 feet by 8 feet (i.e., 8 feet of saturated soil). This equates to approximately 1.4 acres of surface area and approximately 19,000 CY of material requiring treatment. The existing barrier wall extension and treatment system would continue to prevent off-Site migration of impacted groundwater.

2.3.2.3 GROUNDWATER ALTERNATIVE NO. 3 – ENHANCED BIOREMEDIATION, BARRIER WALL EXTENSION AND CONTINUED OPERATION OF AREA 17 IRM

Groundwater Alternative No. 3 utilizes enhanced bioremediation groundwater treatment with barrier wall extension and continued operation of the existing Area 17 containment and recovery system.

For this option, enhanced bioremediation would be utilized to mitigate concerns associated with chloroform in groundwater (covering the same area described in the previous section) while the existing barrier wall extension and treatment system would continue to prevent off-Site migration of impacted groundwater.

3.0 EVALUATION OF CORRECTIVE MEASURE ALTERNATIVES

3.1 METHODS AND CRITERIA USED IN EVALUATION

In accordance with Attachment IV, Task II of the ACO, the standards against which corrective measure alternatives are to be evaluated are as follows:

1. **Technical**
   a. Performance (performance expectations, effectiveness, useful life)
   b. Reliability (demonstrated and expected reliability, operation and maintenance requirements)
   c. Implementability (ease of installation, constructability, time required for installation)
   d. Safety (threats to nearby communities, the environment, and workers during implementation)
2. **Environmental/Human Health** (pathways addressed, short and long-term beneficial and adverse effects of the response)
3. **Institutional**
4. **Cost**

The following sections offer an evaluation of the selected alternatives presented in Section 2.3. As previously noted, the described conceptual designs are provided only for adequate evaluation and comparison. A final design of the chosen alternative will be completed as part of future Site activities. Also note that the cost estimates and schedules included in the evaluation are based upon a conceptual design and are provided only to enable comparison of alternatives.

3.2 SOIL ALTERNATIVES

3.2.1 SOIL ALTERNATIVE NO. 1 – INSTITUTIONAL CONTROLS

Soil Alternative No. 1 is based on use of institutional controls to restrict use of the areas of concern, thereby reducing the potential exposure to benzo(a)pyrene, PCDD/PCDF and TICs areas. Future use and activities (e.g. excavation) would be limited, unless necessary precautions were met. Periodic inspections of the areas would be performed to confirm that the use restrictions continued to be maintained. Specific terms of the restrictions would be detailed as part of final design, but it is anticipated that the institutional controls would include future land use limitations, plus restrictions on disturbance in the areas. If disturbance of the soils was necessary, it would be completed only after appropriate plans and controls were in place (e.g., Health and Safety Plan with appropriate PPE and monitoring).

The following sections evaluate Soil Alternative No. 1 based on the four criteria identified in Section 3.1.

3.2.1.1 TECHNICAL

3.2.1.1.1 PERFORMANCE

Use of institutional controls, alone, would provide limited effectiveness. This alternative can be an effective means of reducing the potential for unacceptable human exposure but cannot prevent or eliminate the risk. Furthermore, with this alternative, future use of the Site and redevelopment options would be severely limited. To maximize effectiveness, periodic inspections could be completed to confirm that restrictions are being followed and that contaminated areas have not been disturbed. This alternative would not effectively prevent potential exposure to ecological receptors.

3.2.1.1.2 RELIABILITY

Similar to performance, expected reliability associated with the use of institutional controls, alone, is low.

3.2.1.1.3 IMPLEMENTABILITY

This alternative can be implemented with little, if any, restriction. With the exception of potential governmental delays associated with recording the restrictions, no difficulties are expected for this alternative.

3.2.1.1.4 SAFETY

Tasks associated with this alternative are administrative in nature. As such, there are no safety risks associated with implementation of this alternative.

3.2.1.2 ENVIRONMENTAL/HUMAN HEALTH

Use of institutional controls could reduce potential human contact with benzo(a)pyrene, PCDD/PCDF and TICs by preventing unacceptable use of the SWMU areas. The use of the property would be limited, and restrictions would be placed on subsurface soil disturbance (e.g. no uncontrolled excavation, limit construction of buildings in certain areas, etc), thereby reducing the potential of human exposure. It should be noted that the Site is already restricted to industrial uses. As such, use of the areas for purposes other than those that are industrial in nature are not a concern.

Although human exposures could be reduced using institutional controls, this alternative would not prevent exposure to potential ecological receptors.

3.2.1.3 INSTITUTIONAL

Institutional needs for this alternative are limited to administrative tasks required to file restrictions with the Wayne County Register of Deeds. Considering the restrictions already in-place, further limited use restrictions are not expected to affect community relations or be hindered by state or local standards, regulations, guidance, advisories or ordinances.

3.2.1.4 COST

The estimated cost to implement this alternative is summarized in Table 3.1. The costs and assumptions provided in Table 3.1 are for comparative purposes only and, based on the components of the alternative, are limited to administrative and inspection tasks.

3.2.1.5 CONCEPTUAL SCHEDULE

A conceptual schedule is provided for comparison of the alternatives. Refer to Table 3.2 for a Gantt chart showing the conceptual schedule for Soil Alternative No. 1.

3.2.2 SOIL ALTERNATIVE NO. 2 – CAPPING

Soil Alternative No. 2 utilizes a soil cap as a physical barrier to remove potential risk of exposure to underlying soils. A 2-foot thick cap with vegetative cover would be installed over the areas depicted on Figure 2.7, thus providing a barrier to impacted soils. Potential risk of exposure would be further mitigated through use of institutional controls, including inspection and maintenance protocol. The following sections evaluate Soil Alternative No. 2 based on the four criteria identified in Section 3.1.

3.2.2.1 TECHNICAL

3.2.2.1.1 PERFORMANCE

Capping is an effective alternative utilized widely at other sites to prevent contact with impacted material. Placement of a soil cover would preclude contact with underlying soils, thus removing direct contact exposures. Additionally, institutional controls, including periodic inspections and maintenance, would be implemented to maintain the barrier and control future use of the areas. By incorporating an inspection and maintenance protocol, including maintaining a robust vegetative cover and managing burrows, etc., this alternative can also be an effective means of mitigating exposure to ecological receptors.

3.2.2.1.2 RELIABILITY

Capping, with institutional controls, is a reliable alternative that has been demonstrated at countless sites. Placement of a cap along with ongoing maintenance would adequately remove direct contact exposures.

Cap maintenance would be paramount to its long-term reliability and effectiveness. Operation and maintenance tasks for this alternative would consist of annual inspection of cover material to ensure integrity of the caps (prevent erosion). During each inspection, the condition of the cover material would be documented and repair activities would be implemented in cases where the cover was disturbed (expected to be limited to potential light grading, filling burrows, etc.).

3.2.2.1.3 IMPLEMENTABILITY

This alternative can be implemented with little or no restriction by the availability of equipment, supplies, materials or manpower. The areas of concern are located in areas of the facility that are open, easily accessible, and away from main plant processes. Administrative processes (permitting requirements) may present moderate restrictions. Refer to Section 3.2.2.3 for detailed permitting requirements.

3.2.2.1.4 SAFETY

There is limited risk of exposure of workers to SWMU related constituents during capping activities. Due to the lack of disturbance of subsurface materials, potential direct contact/inhalation exposures are significantly limited. However, any work performed would be conducted by trained personnel, in accordance with a Site-specific Health and Safety Plan meeting the requirements of 29 CFR 1910.120. The Site-specific Health and Safety Plan would be designed to mitigate any potential exposure, and appropriate PPE would be utilized.

With respect to the community, the areas of construction are located in an industrial area with access controls and security. Additionally, activities would be limited to handling clean fill material. As such, it is unlikely that neighbors would be impacted. However, the Health and Safety Plan would take potential impacts to the community into account and, if necessary, provide means to mitigate the potential impacts. Also, similar activities have been performed at the East Plant and nearby industrial facilities on several occasions without objection from or impacts to the community.

Impacts to the environment would also be limited during implementation of this alternative. Impacted areas of soil would not be exposed and necessary truck decontamination procedures would be implemented to prevent tracking of mud onto adjacent roadways.

3.2.2.2 ENVIRONMENTAL/HUMAN HEALTH

This alternative mitigates exposures by placing and maintaining a cap over contaminated material and through implementation of institutional controls. With a properly maintained cap, potential exposure pathways within the SWMU boundary would be eliminated.

Due to the lack of subsurface disturbance, this alternative does not introduce significant risk of adverse short-term effects on human health or the environment. One potential adverse long-term effect inherent in any capping remedy is degradation of the cover over time. As the cap ages, maintenance requirements would increase. If the cap is allowed to degrade, potential exposures are possible.

3.2.2.3 INSTITUTIONAL

Institutional needs for this alternative are moderately restrictive. Required permits would include a Soil Erosion and Sedimentation Control Permit and a Joint Permit Application.

A Soil Erosion and Sedimentation Control permit is required through Wayne County for any earth change that disturbs one or more acres, or is within 500 feet of a lake or stream. The permit process requires permittees to develop a soil erosion control plan and to ensure that their earth changes do not cause accelerated soil erosion and sedimentation.

An MDNRE and U.S. Army Corps. of Engineers (USACE) Joint Permit is also required due to proximity to the Detroit River and the disturbance of potential on-Site wetlands. Part 31 of Act 451 requires a permit for subsurface activities within the 100-year floodplain and floodway of a river, stream, drain or inland lake. Based on available Federal Emergency Management Agency (FEMA) floodplain maps, the Site is located within the 100-year floodplain of the Detroit River. Part 303 of Act 451 requires a permit for any excavation or filling activities that would be carried out within a wetland. Areas of the Site that contain standing water would need to be evaluated to determine if they meet the definition of a wetland. If wetlands are present these areas would need to be delineated and the wetland boundary would need to be confirmed through a Level 3 Identification by an MDNRE technical specialist under the MDNRE Wetland Identification Program (WIP). The impact to potential wetlands would need to be determined and a mitigation plan may need to be formulated.

City ordinances would be followed with respect to working hours, noise and utilizing public roads for transportation. Additionally, State and Federal Department of Transportation (DOT) regulations would be followed for transportation of materials.

3.2.2.4 COST

The estimated cost to implement this alternative is summarized in Table 3.3. The costs and assumptions provided in Table 3.3 are for comparative purposes only and, depending on actual Site conditions at the time of remediation, and/or other unknown factors, may not reflect the actual final costs.

3.2.2.5 CONCEPTUAL SCHEDULE

A conceptual schedule is provided for comparison of the remedial alternatives. Refer to Table 3.4 for a Gantt chart showing the conceptual construction schedule for Soil Alternative No. 2. The timeline is conceptual and contingent upon several factors including timing of the corrective action; availability of equipment, materials, and subcontractors at the time of implementation; condition of the Site at the time of implementation; and other unknown factors including weather encountered during implementation.

3.2.3 SOIL ALTERNATIVE NO. 3 – EXCAVATION AND OFF-SITE DISPOSAL

Soil Alternative No. 3 consists of excavation and off-Site disposal of impacted soil in areas depicted on Figure 2.7. The following sections evaluate Soil Alternative No. 3 based on the four criteria identified in Section 3.1.

3.2.3.1 TECHNICAL

3.2.3.1.1 PERFORMANCE

Excavation is an effective technology whereby impacted material is removed from prescribed areas depicted on Figure 2.7 and properly disposed at a licensed landfill. Removal of identified areas associated with benzo(a) pyrene and PCDDs/PCDFs would meet the CMS objective for those compounds by reducing risks to acceptable risk levels. Additionally, with respect to TICs, the highest concentrations (i.e., "hot-spots") would be removed, thereby meeting the CMS objective for TICs which is to reduce potential human and ecological exposure concerns.

3.2.3.1.2 RELIABILITY

Excavation/disposal with institutional controls is a reliable alternative that has been demonstrated at countless sites. Excavation activities would permanently remove impacted soil potentially available to receptors, while properly implemented institutional controls would further mitigate potential future exposures. Furthermore, because institutional controls would run with the deed of the property, the reliability of this alternative would not be diminished over time.

Because this alternative relies on removal and off-Site disposal of impacted material, along with implementation of institutional controls, no operation and maintenance tasks are required (i.e., cover material would not require maintenance to prevent contact with underlying soils).

3.2.3.1.3 IMPLEMENTABILITY

This alternative can be implemented with little or no restriction by the availability of equipment, supplies, materials or manpower. The areas of concern are located in areas of the facility that are open, easily accessible, and away from main plant processes. Difficulties that may be encountered include handling of shallow groundwater (if encountered) and fill placement and compaction in limited excavations. However, these issues are manageable using proper equipment. Administrative processes (permitting requirements) may also present moderate restrictions. Refer to Section 3.2.2.3 for detailed permitting requirements.

3.2.3.1.4 SAFETY

There is moderate risk of worker exposure to SWMU related constituents during excavation activities. Potential exposures may consist of direct contact or inhalation of excavated materials. However, any work performed would be conducted by trained personnel, in accordance with a Site-specific Health and Safety Plan meeting the requirements of 29 CFR 1910.120. The Site-specific Health and Safety Plan would be designed to mitigate any potential exposure, and appropriate PPE would be utilized.

With respect to the community, the areas of construction are located in an industrial area with access controls and security. As such, it is unlikely that neighbors would be impacted from contact with excavated material, nuisance odors, potential issues associated with transportation of contaminated material, and/or noisy operations. However, the Health and Safety Plan would take potential impacts to the community into account and, if necessary, provide means to mitigate the potential impacts. Also, excavation activities have been performed at the East Plant and nearby industrial facilities on several occasions without objection from or impacts to the community.

Due to the quantity of material requiring removal, potential impacts to the environment are possible during implementation of this alternative. However, sequenced excavation techniques can be implemented to reduce exposed areas of soil and truck decontamination procedures would be implemented to prevent tracking of material on and off Site.

3.2.3.2 ENVIRONMENTAL/HUMAN HEALTH

This alternative would meet the CMS objective for benzo(a) pyrene and PCDDs/PCDFs by reducing risks to acceptable levels. Additionally, with respect to TICs, the highest concentrations (i.e., "hot-spots") would be removed, thereby meeting the CMS objective for TICs which is to reduce the potential for human and ecological exposures. Because removal of "hot-spots" reduces, but does not eliminate potential risk of exposure, institutional controls (consistent with Soil Alternative No. 1) could be implemented to provide an added level of protection.

This alternative introduces a possibility of adverse short-term effects on human health and/or the environment due to the area of impacted soil that would be exposed during the corrective action. However, sequenced excavation techniques can be implemented to reduce exposed areas of soil. Furthermore, long-term protection of human and ecological receptors would be achieved as a result of removal of SWMU contents and implementation of institutional controls.

3.2.3.3 INSTITUTIONAL

Institutional considerations for this alternative are the same as those identified for Soil Alternative No. 2 (see Section 3.2.2.3).

3.2.3.4 COST

The estimated cost to implement this alternative is summarized in Table 3.5. The costs and assumptions provided in Table 3.5 are for comparative purposes only and, depending on actual Site conditions at the time of remediation, and/or other unknown factors, may not reflect the actual final costs.

3.2.3.5 CONCEPTUAL SCHEDULE

A conceptual schedule is provided for comparison of the remedial alternatives. Refer to Table 3.6 for a Gantt chart showing the conceptual construction schedule for Soil Alternative No. 3. The timeline is conceptual and contingent upon several factors including timing of the corrective action; availability of equipment, materials, and subcontractors at the time of implementation; condition of the Site at the time of implementation; and other unknown factors including weather encountered during implementation.

3.2.4 SOIL ALTERNATIVE NO. 4 - ON-SITE CONSOLIDATION

Soil Alternative No. 4 consists of excavation and on-Site relocation of impacted soil. The excavation and consolidation areas are depicted on Figure 2.7. For this alternative, Areas B, C, D, E, F, G, H and K would be excavated, placed in Area 17, and capped with a 2-foot think soil barrier with vegetative cover. Due to their location beneath the consolidation area, Areas A, I and J would not be excavated.

The total volume of material from Areas B, C, D, E, F, G, H and K would be approximately 42,500 cubic yards. Based on this quantity of material, the consolidation area would be approximately 5 feet in height (3 feet of excavated material and 2 feet of cap) and encompass approximately 8 acres. As shown on Figure 2.7, the area would lie within the boundaries of the existing treatment system sheetpile and slurry walls.

The following sections evaluate Soil Alternative No. 4 based on the four criteria identified in Section 3.1.

3.2.4.1 TECHNICAL

3.2.4.1.1 PERFORMANCE

On-Site consolidation and capping of benzo(a) pyrene, PCDDs/PCDF and TIC impacted soils would meet CMS objectives. Under this alternative, soils from affected areas would be excavated, transported on-Site to Area 17 and capped with a 2-foot soil barrier with vegetative cover. Further protection against the risk of potential exposure would be provided through use of institutional controls. The institutional controls would provide for regular inspection and maintenance of the cap to ensure its integrity and limit activities in the area to protect workers.

Area 17 was selected as the consolidation area due to the presence of like impacts (i.e., movement of soil to this area would not exacerbate Site conditions), as well as long term groundwater control and treatment already occurring in the area. These characteristics allow for compliance with Michigan Act 451, Part 201 administrative rule requirements for relocation of soil on-Site. In accordance with Rule 299.5542 of Michigan Act 451, Part 201, non-hazardous soil can be relocated to similarly contaminated areas on the same site as long as it will not create unacceptable exposures or exacerbate Site conditions.

Upon placement of the soil barrier to prevent direct contact with the material, placement of a vegetative cover to prevent erosion, regular inspections to identify and repair any damaged areas, continued operation, maintenance and monitoring of the existing groundwater treatment system, and implementation of institutional controls to limit activities, the alternative would protect human health and the environment. Additionally, consolidating material in Area 17, which is located in the northeastern corner of the property, would provide an opportunity for redevelopment of more than 80 acres located south of the area.

3.2.4.1.2 RELIABILITY

This alternative would permanently remove impacted soil from areas throughout the Site and consolidate them into a single area that: 1) contains similar impacts; 2) is bound on the north and east by containment walls; 3) has an existing groundwater/DNAPL extraction system on the down-gradient side of the consolidation area that is monitored on a monthly bases; 4) would have a cap that is covered by vegetation to prevent erosion; 5) is subject to regular inspection and maintenance to protect from unacceptable human and ecological exposures and 6) would be subject to further institutional controls to limit activities in the area to protect workers. The resulting unit would be protective of human health and the environment and, because operation and maintenance activities would continue for the life of the alternative and institutional controls would run with the deed of the property, the reliability of this alternative would not be diminished over time.

Cap maintenance would be paramount to its long-term reliability and effectiveness. Operation and maintenance tasks for this alternative would consist of monthly inspection of cover material (during normal monthly operation, maintenance and monitoring activities conducted for the existing extraction/treatment system) to ensure integrity of the cap. During each inspection, the condition of the cover material would be documented and repair activities would be implemented in cases where the cover was disturbed (fill burrows, protect eroded areas, etc.).

3.2.4.1.3 IMPLEMENTABILITY

This alternative can be implemented with little or no restriction by the availability of equipment, supplies, materials or manpower. The areas of concern are located in areas of the facility that are open, easily accessible, and away from main plant processes. Difficulties that may be encountered include handling of shallow groundwater (if encountered) and fill placement and compaction in limited excavations. However, these issues are manageable using proper equipment. Administrative processes (permitting requirements) may also present moderate restrictions. Refer to Section 3.2.2.3 for detailed permitting requirements.

3.2.4.1.4 SAFETY

There is moderate risk of exposure of workers to SWMU related constituents during implementation of this alternative. Potential exposures may consist of direct contact or inhalation of excavated materials. However, any work performed would be conducted by trained personnel, in accordance with a Site-specific Health and Safety Plan meeting the requirements of 29 CFR 1910.120. The Site-specific Health and Safety Plan would be designed to mitigate any potential exposure, and appropriate PPE would be utilized.

With respect to the community, the areas of construction are located in an industrial area with access controls and security. As such, it is unlikely that neighbors would be impacted from contact with excavated material, nuisance odors, potential issues associated with transportation of contaminated material, and/or noisy operations. However, the Health and Safety Plan would take potential impacts to the community into account and, if necessary, provide means to mitigate the potential impacts. Also, excavation activities have been performed at the East Plant and nearby industrial facilities on several occasions without objection from or impacts to the community.

Due to the quantity of material requiring removal and relocation on-Site, potential impacts to the environment are possible during implementation of this alternative. However, sequenced excavation techniques can be implemented to reduce exposed areas of soil and truck decontamination procedures would be implemented to prevent tracking of impacted material.

3.2.4.2 ENVIRONMENTAL/HUMAN HEALTH

This alternative would meet the CMS objective for benzo(a) pyrene and PCDDs/PCDFs by eliminating exposure pathways. Areas from which the benzo(a) pyrene and PCDDs/PCDFs would be removed would no longer exceed the $1x10^{-5}$ risk level and the resulting consolidation would be capped and maintained to remove all human and ecological exposure pathways. Additionally, with respect to TICs, the highest concentrations (i.e., "hot-spots") would be consolidated, capped and maintained, which would meet the CMS objective for TICs which is to reduce the potential for human and ecological exposures.

This alternative introduces a possibility of adverse short-term effects on human health and/or the environment due to the area of impacted soil that would be exposed during the consolidation. However, sequenced excavation techniques can be implemented to reduce exposed areas of soil. Furthermore, long-term protection of human and ecological receptors would be achieved through implementation of institutional controls, including regular cap inspection and maintenance.

3.2.4.3 INSTITUTIONAL

Institutional considerations for this alternative are the same as those identified for Soil Alternative No. 2 (see Section 3.2.2.3).

3.2.4.4 COST

The estimated cost to implement this alternative is summarized in Table 3.7. The costs and assumptions provided in Table 3.7 are for comparative purposes only and, depending on actual Site conditions at the time of remediation, and/or other unknown factors, may not reflect the actual final costs.

3.2.4.5 CONCEPTUAL SCHEDULE

A conceptual schedule is provided for comparison of the remedial alternatives. Refer to Table 3.8 for a Gantt chart showing the conceptual construction schedule for Soil Alternative No. 4. The timeline is conceptual and contingent upon several factors including timing of the corrective action; availability of equipment, materials, and subcontractors at the time of implementation; condition of the Site at the time of implementation; and other unknown factors including weather encountered during implementation.

3.3 GROUNDWATER ALTERNATIVES

3.3.1 GROUNDWATER ALTERNATIVE NO. 1 – INSTITUTIONAL CONTROLS WITH MONITORING, BARRIER WALL EXTENSION AND CONTINUED OPERATION OF AREA 17 IRM

Groundwater Alternative No. 1 is based on use of institutional controls to restrict use of Area 17, thereby mitigating potential exposure pathways associated with chloroform. Along with the institutional controls a regular monitoring program would be implemented and the existing containment and recovery system would continue to operate. The following sections evaluate Groundwater Alternative No. 1 based on the four criteria identified in Section 3.1.

3.3.1.1 TECHNICAL

3.3.1.1.1 PERFORMANCE

With respect to chloroform, which is present in the groundwater only and not readily available for consumption or contact, use of institutional controls is an effective alternative for reducing the potential for unacceptable exposures to chloroform. Based on the Human Health Risk Assessment (ESI, July 2004) the remaining exposure pathways of concern are related to potential future construction and office workers. To mitigate this pathway, future use of Area 17 would be limited through the use of deed restrictions. Future use (i.e., construction of buildings) and activities (e.g. excavation) would be limited, unless necessary precautions were met.

To mitigate migration of impacted groundwater, this option utilizes the barrier wall extension and the existing treatment system. The barrier wall extension, comprised of IMPERMIX®, and installed using Vibrated Beam technology, was tied into the western edge of the existing northern sheetpile wall and extended 600 feet to the west. The alignment of the extension and method of installation provides a continuous cut-off wall (with a typical in-situ permeability of approximately 1×10^{-8} cm/sec) effectively preventing migration of impacted groundwater to the north. Slurry walls are a full-scale technology that have been used for decades as long-term solutions for controlling migration of contaminated groundwater.

The existing treatment system has been operating since 2001 and consists of the following elements:

- Containment walls
- Groundwater extraction system
- Enhanced groundwater extraction (Phytoremediation)
- Soil cover
- Groundwater treatment system
- Groundwater monitoring

The treatment system has been monitored since 2001 and has been proven effective (see evaluations described in Sections 2.2.2.1 through 2.2.2.4).

As part of this alternative a regular groundwater monitoring program would be implemented and consist of annual sampling of the following wells (refer to Figure 2.8):

- IRM-MW-1
- IRM-MW-2
- IRM-MW-3
- MW009
- MW109
- MW209
- MW10A
- MW011
- MW016
- MW017
- MW022
- MW025

The purpose of the annual event would be to monitor groundwater quality in the area (upgradient, source area and downgradient), ensure that impacts do not migrate around the southern end of the containment wall, and gauge DNAPL levels in area monitoring wells. Where encountered, DNAPL would be recovered from monitoring wells using a peristaltic pump (this recovery would be in addition to the active treatment system recovery).

3.3.1.1.2 RELIABILITY

Based on the remaining exposure pathways associated with chloroform, controlling future uses and activities (i.e., not allowing construction of buildings) within Area 17 is a reliable means of preventing potential risk of exposures to chloroform.

With respect to migration of impacted groundwater, the newly installed barrier wall extension provides a robust cut-off wall along the north property boundary and the existing treatment system provides reliable capture and treatment of groundwater and DNAPL prior to migration to the Trenton Channel. These containment technologies are proven and there are no known Site or waste characteristics that would impede the effectiveness of these components over time.

Operation, maintenance and monitoring requirements for this alternative would consist of the following tasks:

- Perform monthly inspections to monitor the pumps, processes and equipment as necessary, and perform preventive maintenance tasks
- Perform monthly collection of water levels in the Trenton Channel and Area 17 wells
- Quarterly treatment system effluent sampling
- Annual groundwater monitoring throughout Area 17

3.3.1.1.3 IMPLEMENTABILITY

This alternative can be implemented with little, if any, restriction. With the exception of potential governmental delays associated with recording the restrictions, no difficulties are expected for this alternative.

3.3.1.1.4 SAFETY

Tasks associated with implementing institutional controls are administrative in nature. There are no safety risks associated with implementing this component.

With respect to continued operation of the Area 17 containment and recovery system, there is limited risk of exposure to workers except potential direct contact/inhalation exposures during operation and maintenance activities. Any work performed would be conducted by trained personnel, in accordance with a Site-specific Health and Safety

Plan meeting the requirements of 29 CFR 1910.120. The Site-specific Health and Safety Plan would be designed to mitigate any potential exposure, and appropriate PPE would be utilized.

Implementation of this alternative does not present risk of exposure to the community or the environment.

3.3.1.2 ENVIRONMENTAL/HUMAN HEALTH

For groundwater impacts there are two areas of concern. One associated with chloroform in MW017 and one associated with potential migration of impacted groundwater to the Trenton Channel. Groundwater Alternative No. 1 mitigates both concerns through implementation of institutional controls and by containing/recovering impacts.

Use of institutional controls would reduce potential exposures to chloroform by removing the potential for unacceptable use of Area 17. The use of the property in this area would be limited, and restrictions would run with the deed of the property prohibiting construction of buildings and subsurface disturbance unless necessary precautions were met. Additionally, the presence of the northern barrier wall and ongoing groundwater extraction/treatment, which has been shown to be effective, mitigates potential contaminant migration concerns.

With proper implementation of the institutional controls and on-going operation, maintenance and monitoring tasks, exposure pathways within Area 17 would be eliminated with no short or long-term adverse effects to human health or the environment.

3.3.1.3 INSTITUTIONAL

Institutional needs for this alternative are limited to administrative tasks required to file restrictions with the Wayne County Register of Deeds.

3.3.1.4 COST

The estimated cost to implement this alternative is summarized in Table 3.9. The costs provided in Table 3.9 are for comparative purposes only and, based on the components of the alternative, are limited to administrative and O&M tasks.

3.3.1.5 CONCEPTUAL SCHEDULE

A conceptual schedule is provided for comparison of the alternatives. Refer to Table 3.10 for a Gantt chart showing the conceptual schedule for Groundwater Alternative No. 1.

3.3.2 GROUNDWATER ALTERNATIVE NO. 2 – ISCO, BARRIER WALL EXTENSION AND CONTINUED OPERATION OF AREA 17 IRM

Groundwater Alternative No. 2 is based on use of ISCO to mitigate concerns associated with chloroform in groundwater while the existing barrier wall extension and treatment system would continue to prevent off-Site migration of impacted groundwater. The following sections evaluate Groundwater Alternative No. 2 based on the four criteria identified in Section 3.1.

3.3.2.1 TECHNICAL

3.3.2.1.1 PERFORMANCE

ISCO is an effective technology for destroying a wide range of VOCs. The technology is based on the use of strong oxidizing agents to completely oxidize the VOC within relatively short periods. In a chemical oxidation reaction, the oxidizing agent breaks the double carbon bonds in chlorinated compounds and converts them within hours into non toxic compounds, primarily carbon dioxide, water and chloride.

To evaluate the performance of ISCO, CRA performed a Treatability Study (see Section 2.2.4.1 and Appendix D). Based on the results of the study, it appears that chemical oxidation treatment may achieve reductions in chloroform levels. During the study, 50 percent of the chloroform in the soil and 43 percent in the groundwater was removed by chemical oxidation over a two-week study period.

ISCO is site-specific, and successful treatment is often a function of the effectiveness of the delivery system, the ease of transport of the oxidant within the aquifer and the ability of the oxidant to come in contact with and oxidize the contaminants. These items cannot be fully assessed during a bench scale treatability study and may introduce potential performance difficulties. Additionally, the following potential scenarios may affect performance:

- The presence of potential free phase chloroform may significantly increase remediation time.
- Subsurface heterogeneity that exists on-Site can cause uneven distribution of oxidants leading to an increased number of required injections to fully remediate the groundwater plume.
- "Rebound" may occur, causing an increased amount of time to remediate. "Rebound effects" are common and are caused by fluctuations in groundwater levels (fluctuations caused by seasonal variations or pumping). When the groundwater level depresses, residual contaminants may remain sorbed to the soil and after the groundwater level returns to its normal level, contaminants sorbed onto soil are dissolved back into the groundwater.
- Metals may be mobilized causing additional impacts.
- Use of this technology may reduce the porosity of the subsurface due to the formation of precipitates, which may increase time to remediate.

3.3.2.1.2 RELIABILITY

ISCO is a proven technology, demonstrated to be reliable at sites around the world. With effective delivery of oxidant, ISCO is capable of achieving project objectives. Site-specific limitations and potential oxidation-induced effects that may reduce reliability are similar to those described in the previous section.

3.3.2.1.3 IMPLEMENTABILITY

This alternative can be implemented with moderate to heavy restriction due to administrative requirements. The MDNRE requires that in-situ remedies go through State review for approval. This approval is necessary to attain a groundwater discharge permit exemption pursuant to R323.2210(u) of the Part 22 Rules promulgated under Part 31 of the Natural Resources and Environmental Protection Act (NREPA). The review/response process can take several months and the final MDNRE decision may introduce additional limitations.

In addition to potential administrative obstacles, due to natural oxidant demand (NOD) (see Appendix D), it is estimated that approximately 16 applications of Fenton's Reagent would be required to treat the chloroform by chemical oxidation (assuming effective delivery of oxidants to the subsurface). To inject this amount, applications would be made at two-month intervals for approximately three years. Based on the large number of required injections over an area exceeding one-acre, the cost of the Fenton's Reagent is an additional potential limitation.

From a construction standpoint, ISCO can be implemented with limited restriction. The area where ISCO injections would take place is generally open and easily accessible. Equipment, materials and services required for implementation are locally or regionally available.

3.3.2.1.4 <u>SAFETY</u>

There is moderate to high risk of adverse exposure of workers to hazardous oxidizing chemicals during implementation of this alternative. As the process would involve injection of reagent (i.e., no removal of contaminated soil or groundwater), adverse exposure to Area 17-related constituents would not be a concern. For this option, large quantities of hydrogen peroxide (H_2O_2) and ferrous sulfate (Fe) would be required and present the potential for direct contact or inhalation exposures. Additionally, oxidation reactions generate heat. Any work performed would be conducted by trained personnel, in accordance with a Site-Specific Health and Safety Plan meeting the requirements of 29 CFR 1910.120. The Site-Specific Health and Safety Plan would be designed to mitigate any potential exposure, and appropriate PPE would be utilized.

With respect to the community, the area of construction is located more than 1,000 feet from residential properties. As such, it is unlikely that neighbors would be impacted by operations. The Site-Specific Health and Safety Plan would take potential impacts to the community into account and, if necessary, provide means to mitigate the potential impacts. Also, construction activities have been performed at the East Plant and nearby industrial facilities on several occasions without objection from or impacts to the community.

Potential impacts to the environment are similar to those described above and would be primarily due to the presence of large quantities of hazardous oxidizing chemicals.

Adverse affects on the environment due to exposures to Area 17-related constituents would not be a concern.

3.3.2.2 ENVIRONMENTAL/HUMAN HEALTH

ISCO treatability study results suggest that with effective delivery of oxidant, ISCO is capable of destroying chloroform in affected Site groundwater. Additionally, the presence of the northern barrier wall and ongoing groundwater extraction/treatment (which has been proven to be effective), mitigates potential contaminant migration concerns. With acceptable chloroform levels, transient oxidation-induced effects and continued groundwater containment, potential exposure pathways within Area 17 would be eliminated.

Potential adverse effects are possible using ISCO and may include:

- Acute exposures associated with the handling of large quantities of hazardous oxidizing chemicals
- Uneven delivery of oxidants or the presence of free phase chloroform may significantly increase remediation time
- Mobilization of metals
- Reduced porosity of the subsurface due to the formation of precipitates

3.3.2.3 INSTITUTIONAL

Institutional needs for this alternative are potentially extensive, as discussed in 3.3.2.1.3 (Implementability). Obtaining a groundwater discharge permit exemption pursuant to R323.2210(u) of the Part 22 Rules may be cumbersome and time consuming.

City ordinances would be followed with respect to working hours, noise and utilizing public roads for transportation. Additionally, State and Federal Department of Transportation (DOT) regulations would be followed with respect to transportation of necessary materials.

3.3.2.4 COST

The estimated cost to implement this alternative is summarized in Table 3.11. The costs and assumptions provided in Table 3.11 are for comparative purposes only and, depending on actual Site conditions at the time of remediation, and/or other unknown factors, may not reflect the actual final costs.

3.3.2.5 CONCEPTUAL SCHEDULE

A conceptual schedule is provided for comparison of the remedial alternatives. Refer to Table 3.12 for a Gantt chart showing the conceptual construction schedule for Groundwater Alternative No. 2. The timeline is conceptual and contingent upon several factors including timing of the corrective action; availability of equipment, materials, and subcontractors at the time of implementation; condition of the Site at the time of implementation; and other unknown factors including weather encountered during implementation.

3.3.3 GROUNDWATER ALTERNATIVE NO. 3 – ENHANCED BIOREMEDIATION, BARRIER WALL EXTENSION AND CONTINUED OPERATION OF AREA 17 IRM

Groundwater Alternative No. 3 is based on use of enhanced bioremediation to mitigate concerns associated with chloroform in groundwater while the existing containment and recovery system would continue to prevent off-Site migration of impacted groundwater. The following sections evaluate Groundwater Alternative No. 3 based on the four criteria identified in Section 3.1.

3.3.3.1 TECHNICAL

3.3.3.1.1 PERFORMANCE

Enhanced bioremediation is a proven and effective remediation technology whereby contaminants are metabolized into less toxic or non-toxic compounds by naturally occurring microorganisms. Under this alternative biodegradation processes would be enhanced by the injection of electron acceptors (soy lactate) and nutrients.

Soy lactate enhances reductive dechlorination (the process by which chlorinated compounds are degraded) and it provides a carbon source for anaerobic bacteria. In reductive dechlorination chloroform is degraded to methylene chloride, then to chloromethane and ultimately to methane (which dissipates and is further metabolized by existing microorganisms).

Nutrient solutions contain nitrogen and phosphorus in forms that microorganisms can easily use. These nutrients are necessary for growth of the organisms, even if carbon is readily available.

To evaluate the performance of enhanced bioremediation, CRA performed a Treatability Study (see Section 2.2.4.2 and Appendix D). Based on the results of the study, it appears that enhanced bioremediation, although less aggressive than ISCO, may achieve reductions in chloroform levels. During the study, 29 percent of the chloroform in the soil and groundwater microcosms was removed by biological treatment during the 8-weeks study period.

Similar to ISCO, successful treatment is a function of the effectiveness of delivery of the amendments. This cannot be fully assessed during a bench scale treatability study and may introduce potential performance difficulties. Additionally, the potential presence of free phase chloroform may significantly increase or inhibit remediation time.

3.3.3.1.2 RELIABILITY

Enhanced bioremediation is a proven technology, demonstrated to be reliable at sites around the world. With effective delivery of amendments, enhanced bioremediation is capable of achieving project objectives. Site-specific limitations that may reduce reliability are similar to those described in the previous section.

3.3.3.1.3 IMPLEMENTABILITY

This alternative can be implemented with moderate restriction due to administrative requirements. As with groundwater Alternative No. 2, this option would require MDNRE approval to attain a groundwater discharge permit exemption pursuant to R323.2210(u) of the Part 22 Rules promulgated under Part 31 of NREPA. Although the review/response process for enhanced bioremediation is expected to be less cumbersome than with ISCO, it may take several months and the final MDNRE decision may introduce additional limitations.

Assuming effective delivery of amendments and lack of free phase chloroform, it is estimated that approximately five years would be required to complete biological treatment of the chloroform. During the estimated 5-year period, approximately three applications of amendments (soy lactate and nutrients) would be required.

From a construction standpoint, enhanced bioremediation can be implemented with limited restriction. The area where treatment would take place is generally open and easily accessible. Equipment, materials and services required for implementation are locally or regionally available.

3.3.3.1.4 SAFETY

There is limited risk of adverse exposure to workers during implementation of this alternative. Activities would consist of installation of injection points, injection of amendments and monitoring. Amendments that would be added are non-toxic and the process would not involve direct contact with constituents of concern. Any work performed under this alternative would be conducted by trained personnel, in accordance with a Site-Specific Health and Safety Plan meeting the requirements of 29 CFR 1910.120. The Site-Specific Health and Safety Plan would be designed to mitigate any potential exposure, and appropriate PPE would be utilized.

With respect to the community, the area of construction is located more than 1,000 feet from residential properties. As such, it is unlikely that neighbors would be impacted by operations. The Site-Specific Health and Safety Plan would take potential impacts to the community into account and, if necessary, provide means to mitigate the potential impacts. Also, construction activities have been performed at the East Plant and nearby industrial facilities on several occasions without objection from or impacts to the community.

Potential impacts to the environment during implementation of this alternative are also limited. Activities are primarily above ground, using non-toxic amendments, without disturbance of contaminated media.

3.3.3.2 ENVIRONMENTAL/HUMAN HEALTH

Enhanced bioremediation treatability study results suggest that with effective delivery of amendments, the treatment is capable of reducing chloroform to acceptable levels over time. Additionally, the presence of the northern barrier wall and ongoing groundwater extraction/treatment (which has been proven to be effective), mitigates potential contaminant migration concerns. With acceptable chloroform levels, and continued groundwater containment, potential exposure pathways within Area 17 would be eliminated.

Potential adverse effects using this alternative are generally limited to the amount of time required for remediation. Enhanced bioremediation is not a short-term remedy and its effectiveness can be influenced by subsurface heterogeneity, which may cause uneven delivery of amendments, or the presence of free phase chloroform, which may significantly increase or inhibit remediation.

3.3.3.3 INSTITUTIONAL

Institutional needs for this alternative are potentially extensive, as discussed in 3.3.3.1.3 (Implementability). Obtaining a groundwater discharge permit exemption pursuant to R323.2210(u) of the Part 22 Rules may be cumbersome and time consuming.

City ordinances would be followed with respect to working hours, noise and utilizing public roads for transportation. Additionally, State and Federal Department of Transportation (DOT) regulations would be followed with respect to transportation of necessary materials.

3.3.3.4 COST

The estimated cost to implement this alternative is summarized in Table 3.13. The costs and assumptions provided in Table 3.13 are for comparative purposes only and, depending on actual Site conditions at the time of remediation, and/or other unknown factors, may not reflect the actual final costs.

3.3.3.5 CONCEPTUAL SCHEDULE

A conceptual schedule is provided for comparison of the remedial alternatives. Refer to Table 3.14 for a Gantt chart showing the conceptual construction schedule for Groundwater Alternative No. 3. The timeline is conceptual and contingent upon several factors including timing of the corrective action; availability of equipment, materials, and subcontractors at the time of implementation; condition of the Site at the time of implementation; and other unknown factors including weather encountered during implementation.

4.0 JUSTIFICATION AND RECOMMENDATION FOR CORRECTIVE MEASURE ALTERNATIVES

4.1 RATIONALE SUPPORTING SELECTION

In this section, the alternatives are comparatively evaluated to assist in the selection of the recommended Final Corrective Measure Alternatives. This allows alternatives, which are similar in terms of the overall Corrective Measure Study criteria to be differentiated and a Final Corrective Measure Alternative to be selected.

To assist in the evaluation, a relative scoring system has been used for each of the Corrective Measure Study Criteria and is presented on Table 4.1. As shown, total scores equal to the number of alternatives have been assigned to each of the following criteria:

1. **Technical**
   a. Performance (performance expectations, effectiveness, useful life)
   b. Reliability (demonstrated and expected reliability, operation and maintenance requirements)
   c. Implementability (ease of installation, constructability, time required for installation)
   d. Safety (threats to nearby communities, the environment, and workers during implementation)
2. **Environmental/Human Health** (pathways addressed, short and long-term beneficial and adverse effects of the response)
3. **Institutional**
4. **Cost**

The alternative best meeting the requirements of a criterion (when compared to the other alternatives) receives a full score (equal to the number of alternatives). The score is then reduced for each successive alternative that fails to achieve any or all aspects of the criterion.

The following sections provide rationale for the ranking given to each alternative.

4.1.1 RANKING SOIL ALTERNATIVES

1. **Technical**

   Performance/Reliability:

   Excavation and off-Site disposal (Alternative No. 3) removes areas of concern from the Site and meets the CMS objectives of eliminating exposure pathways associated with PCDDs/PCDF and benzo(a)pyrene and reducing the risk of potential exposure to TICs. As such, Alternative No. 3 exhibits the highest level of performance and is most reliable with respect to meeting CMS objectives. Alternative No. 4 also meets the CMS objectives of eliminating exposure pathways associated with PCDDs/PCDF and benzo(a)pyrene and reducing the risk of potential exposure to TICs but results in a 8-acre capped area on-Site that requires regular inspection and maintenance to ensure on-going protection of human health and the environment. This inspection/maintenance component makes Alternative No. 4 slightly less reliable than Alternative No. 3. Alternative No. 2 (capping by area) involves the same inspection/maintenance component as Alternative No. 4 and, as such, is ranked the same from a performance and reliability standpoint. Alternative No. 1, which relies solely on use of institutional controls, would be the least reliable.

   Implementability/Safety:

   Alternative No. 1, which relies primarily on administrative processes, is the most readily implementable and safest alternative to execute. Alternative No. 2, although also readily implementable and safe to execute, involves surface construction activity to cap individual areas of concern. As such, Alternative No. 2, ranks slightly behind Alternative No. 1 in these categories. Alternative Nos. 3 (excavation and off-Site disposal) and 4 (on-Site consolidation), both involve intrusive activity with potential for adverse exposure. Alternative No. 3, which involves the largest amount of excavation and also off-Site transport of impacted material, scores the lowest with respect to implementability and safety.

2. **Environmental/Human Health:**

   Rationale for ranking alternatives based on these criteria is essentially the same as that for Performance/Reliability, described above. Excavation and off-Site disposal (Alternative No. 3) completely removes areas of concern from the Site and meets the CMS objectives of eliminating exposure pathways associated with to PCDDs/PCDF and benzo(a)pyrene and reducing the risk of potential exposure to TICs. As such, Alternative No. 3 affords the highest level of protection to human health and the environment. Alternative No. 4, which consolidates/caps areas of concern in one location on-Site is similar to the excavation alternative with respect to meeting the CMS objectives, but requires a regular inspection/maintenance component to ensure on-going protection of human health and the environment. This inspection/maintenance component makes Alternative No. 4 slightly less protective than Alternative No. 3. Alternative No. 2 (capping by area) involves the same inspection/maintenance component as Alternative No. 4 and, as such, is ranked the same as Alternative No. 4. Alternative No. 1, which relies solely on use of institutional controls, would be the least protective.

3. **Institutional:**
   Alternative No. 1, which relies primarily on deed restrictions, is the least restrictive from an institutional requirement standpoint. Alternative Nos. 2, 3 and 4 require essentially the same deed restrictions as Alternative No. 1, plus certain permits to conduct the work as a result of disturbing potential wetlands and working within a floodplain. As Alternative Nos. 2, 3 and 4 have essentially the same institutional needs, each are ranked the same in this category.

4. **Cost**:
   In accordance with the Administrative Consent Order (ACO) for the Site dated September 21, 1989, cost was not considered in the ranking for Alternative No. 1. Cost may be considered only if the alternative is deemed acceptable when evaluated for technical, human health and environmental criteria. As identified in Tables 3.3 (Alternative No. 2), 3.5 (Alternative No. 3) and 3.7 (Alternative No. 4), Alternative No. 2 (capping) is the least expensive, followed by Alternative No. 4 (on-Site consolidation) and then Alternative No. 3 (excavation and off-Site disposal).

4.1.2 RANKING GROUNDWATER ALTERNATIVES

1. **Technical**
   Performance/Reliability:
   The CMS objectives for groundwater are limited to Area 17 and include 1) eliminating potential exposure pathways[1] associated with chloroform and 2) addressing migration of DNAPL and concentrations of dissolved Site-related constituents that may adversely impact water quality. Alternative No. 1 was ranked highest for meeting these objectives due to the active containment and recovery and treatment process that is currently underway and has been shown to be effective and the uncertainties involved with delivery of amendments, potential metals mobilization, rebound and treatment timeframes for the remaining in-situ

[1] Based on the Human Health Risk Assessment (ESI, July 2004) the remaining exposure pathways of concern are related to potential future construction and office workers.

alternatives. Alternative No. 2 (ISCO) was ranked second based on treatability study results, which estimated higher destruction rates and a more rapid treatment timeframe than Alternative No. 3 (enhanced bioremediation).

Implementability/Safety:
Alternative No. 1, which relies on administrative processes for institutional controls and continued operation of the existing containment and recovery system is the most readily implementable and safest alternative to execute. Alternative No. 3, was ranked second based on the availability and non-toxic nature of the in-situ amendments. Alternative No. 2, which involves high quantities of hazardous oxidizing chemicals, scores the lowest with respect to implementability and safety.

2. **Environmental/Human Health:**
The rationale for ranking alternatives based on these criteria is essentially the same as that for Performance/Reliability, described above. Alternative No. 1 was ranked highest due to the ease with which institutional controls could be implemented to eliminate potential exposure to chloroform and the active containment and recovery and treatment process that is currently underway and meeting objectives. Alternative No. 2 (ISCO) was ranked second based on uncertainties involved with delivery of amendments, potential metals mobilization, rebound and treatment timeframes. Alternative No. 3 (enhanced bioremediation) ranked last based on treatability study results, which estimated lower destruction rates and a longer required treatment timeframe than Alternative No. 2.

3. **Institutional:**
Alternative No. 1, which relies on administrative processes for institutional controls and continued operation of the existing containment and recovery system, is the least restrictive in this category. Alternative Nos. 2 and 3 require essentially the same deed restrictions as Alternative No. 1, plus certain agency approval requirements as a result of in-situ discharges. As Alternative Nos. 2 and 3 have essentially the same institutional needs, each are ranked the same in this category.

4. **Cost**:
As identified in Tables 3.9 (Alternative No. 1), 3.11 (Alternative No. 2) and 3.13 (Alternative No. 3), Alternative No. 1 is the least expensive, followed by Alternative No. 3 (enhanced bioremediation) and then Alternative No. 2 (ISCO).

4.2 RECOMMENDED CORRECTIVE MEASURE ALTERNATIVES

Recommended Soil Alternative

As demonstrated in Table 4.1, and summarized above, Soil Alternative No. 2 (Capping) shows a higher score than the remaining alternatives primarily due to favorable implementability, safety and cost. Because Alternative Nos. 2, 3 and 4 each meet the CMS objectives of eliminating exposure pathways associated with PCDDs/PCDFs and benzo(a)pyrene and reducing the risk of potential exposure to TICs, selection of the recommended alternative falls on considerations such as implementability, safety and cost as well as those that are not fully considered in the ranking system, such as potential for redevelopment and aspects of "Green Remediation". U.S. EPA's Technology Primer: "Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites" of April 2008 (U.S. EPA 542-R-08-002) recognizes there is a "footprint" of remediation, which can include collateral environmental impacts and damage through such consequences as green house gas emission and high energy consumption. "Dig and haul" for treatment/long term storage elsewhere is a remediation approach which certainly creates a significant footprint, which should be considered in the choice of a remedy.

Based on the information provided herein, Soil Alternative No. 2 is the recommended corrective action for soil impacts at the East Plant. However, in consideration of optimizing the Site for potential future redevelopment opportunities, LSS may consider a combination of alternatives such as partial excavation with off-Site disposal of certain areas within the central portion of the Site (e.g., Area K and F, depicted on Figure 2.7), along with capping. Whether capping is selected as the sole option, or combined with excavation to optimize redevelopment potential, LSS believes in maximizing the net environmental benefit of cleanup actions by establishing cleanup programs that use natural resources and energy efficiently.

Recommended Groundwater Alternative

As demonstrated in Table 4.1, and summarized above, Groundwater Alternative No. 1 – Institutional controls and monitoring along with the barrier wall extension and continued operation of the existing Area 17 containment and recovery system shows a higher score than the remaining alternatives. Alternative No. 1 ranks higher in the categories because the existing IRM along with institutional controls meet the CMS objectives and because there are a number of inherent uncertainties involved with the in-Situ remedies.

Based on the information provided herein, Groundwater Alternative No. 1 is the recommended corrective action for groundwater impacts in Area 17. This is justified given that the alternative: a) meets the stated CMS objectives; b) includes containment walls to the north and east that provides containment of existing chloroform and DNAPL; c) includes a recovery system that allows for capture, recovery and treatment or disposal of impacted groundwater, including chloroform and DNAPL; d) would be subject to institutional controls that would eliminate exposure pathways associated with chloroform (prohibiting construction of buildings and excavation); e) would be supported by readily available local resources to inspect and maintain the containment and recovery system on a monthly basis to ensure that the system is operating properly and that restrictions are followed; and f) would be subject to annual groundwater monitoring of 12 wells throughout Area 17 to monitor on-going conditions. Annual monitoring would include gauging for and active recovery of any DNAPL encountered in the monitoring wells to supplement the recovery of DNAPL occurring as part of the IRM.

5.0 REFERENCES

1. Conestoga-Rovers & Associates, Inc., Supplemental Sediment Survey Report, Arkema Inc. East Plant, Riverview/Wyandotte, Michigan. November 10, 2006.

2. Conestoga-Rovers & Associates, Inc., Revised Corrective Measure Study Work Plan, East Plant, Arkema Inc., Riverview/Wyandotte, Michigan. June 16, 2006.

3. Environmental Standards, Inc. Evaluation of Tentatively Identified Compounds Reported at Arkema Inc., East Plant, Riverview Michigan (TIC Evaluation). June 13, 2006.

4. Conestoga-Rovers & Associates, Inc., Supplemental Soft Sediment Survey Work Plan, Arkema Inc. East Plant, Riverview/Wyandotte, Michigan. March 1, 2006.

5. Conestoga-Rovers & Associates, Inc., Sediment Survey Report, Arkema Inc. East Plant,, Riverview/Wyandotte, Michigan. December 19, 2005.

6. Conestoga-Rovers & Associates, Inc., Soft Sediment Survey Work Plan, Arkema Inc. East Plant, Riverview/Wyandotte, Michigan. July 20, 2005.

7. Conestoga-Rovers & Associates, Inc., Revised Environmental Indicator Determination (CA 750), Arkema Inc. East Plant, West Plant and West Brine Field, Riverview/Wyandotte, Michigan. June 7, 2005.

8. Conestoga-Rovers & Associates, Inc. RCRA Facility Investigation Report, East Plant, ATOFINA Chemicals, Inc., Riverview, Michigan. July 29, 2004.

9. Environmental Standards, Inc. Human Health and Ecological Risk Assessments for the ATOFINA Chemicals, Inc., Riverview, Michigan East Plant Property. July 28, 2004.